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SCIENCE AND TECHNOLOGY

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2 JULY 1986

JAPAN REPORT

SCIENCE AND TECHNOLOGY

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AEROSPACE SCIENCES

DETAILS OF CURRENT SPACE DEVELOPMENT PLAN DESCRIBED

Tokyo KOKU TENBO in Japanese 1985 pp 489-508

[Excerpt] 2. Present Situation of Japanese Space Development

2.1. Present Status of Research

The Space Development Committee forms a space development plan to proceed with space development comprehensively under a unified national policy and reviews it every fiscal year.

The first space development plan was formed in October 1969 and later plans were formed in October 1970, March 1973, and March of every year between 1973 and 1985.

The current Space Development Plan (enacted 13 March 1985) was formed in response to new needs by reviewing the Space Development Plan (enacted 14 March 1984) in accordance with the aforementioned General Policy on Space Development and in consideration of the progress of domestic research and development, changes in the international environment and the long-range outlook concerning the uses of space development.

The Space Development Plan (13 March 1985) is outlined below.

(1) Scientific Aspect of Development Plan

In the scientific aspect, the 6th scientific satellite "Jikiken," the 4th scientific satellite "Hakucho," the 7th scientific satellite "Hinotori," the 8th scientific satellite "Tenma," the 9th scientific satellite "Ozora" and the experimental planetary probe "Sakigake" are operated, development will be executed to launch the 10th scientific satellite (PLANET-A) in fiscal 1985, the 11th scientific satellite (ASTRO-C) in fiscal 1986, the 12th scientific satellite (EXOS-D) in fiscal 1988, and the 13th scientific satellite (MUSES-B) in fiscal 1989, each by the M rocket, and there will be research to develop the magnetosphere observing satellite "GEOTAIL."

(2) Observation Aspect of Development Plan

In the aspect of observation, Geostationary Meteorological Satellite No 3 "Himawari" will be operated and Geostationary Meteorological Satellite No 2 "Himawari" and Geostationary Meteorological Satellite "Himawari" will be controlled. Development will be executed to launch Marine Observation Satellite No 1 (MOS-1) in fiscal 1986 by the N-II rocket. Also, research will be continued to develop Earth Resources Satellite No 1 (ERS-1).

(3) Communications Aspect of Development Plan

The experimental medium-capacity geostationary communications satellite "Sakura," Communications Satellite No 2-a and b "Sakura 2-a and 2-b" and Broadcasting Satellite No 2-a "Yuri" will be operated and plans to launch Broadcasting Satellite No 2-b (BS-2b) in fiscal 1985 by the N-II rocket and Communications Satellite No 3-a (CS-3a) in fiscal 1987, Communications Satellite No 3-b (CS-3b) in fiscal 1988, Broadcasting Satellite No 3-a (BS-3a) in fiscal 1988, and Broadcasting Satellite No 3b (BS-3b) in fiscal 1990, each by the H-I rocket, will be continued.

(4) Space Test Aspect of Development Plan

In the aspect of space tests, test systems will continue to be developed and Japanese scientists and technicians to man space shuttles will continue to be selected with the object of conducting in fiscal 1987 the first material test (FMPT) aimed at enabling these scientists and technicians to make material and other tests, taking advantage of the characteristics of outer space.

(5) Space Station Aspect of Development Plan

The preliminary design, etc. of testing modules of the type to be attached to the space station will be carried out in preparation for participation in work at the phase of preliminary design (Phase B) under the U.S. Space Station Project.

(6) Development Plan Aspect Concerning Techniques Common to Artificial Satellite Systems

In the aspect of techniques common to artificial satellite systems, development will be executed to launch Engineering Test Satellite, Type V (ETS-V) in fiscal 1987 by an experimental H-I rocket.

① The M-rocket will use solid fuel for all stages. Its performance and reliability will be improved through gradual reformation based on the past accumulation of techniques. Specifically, an M-3SII rocket will be developed as an improved type of the M-3S rocket with the object of using it to launch four scientific satellites by fiscal 1989.

② The N-II rocket, a three-stage rocket with a launching capacity improved from the N-I rocket and capable of launching a satellite of about 350 kg into a geostationary orbit, will be developed with the object of launching two satellites by fiscal 1986.

③ The H-I rocket to handle the launching of artificial satellites during the period of 1985-1994 will continue to be developed as a three-stage rocket capable of launching a geostationary satellite of about 550 kg and using the first-stage liquid rocket of the N-II rocket for its first stage, an engine propelled by liquid oxygen/liquid hydrogen for its second stage and a large solid motor for its third stage and employing inertial guidance as its guiding formula.

In this connection, an experimental H-I rocket (two-stage) with such aims as a trajectory test for the second stage and the confirmation of functions of the inertial guidance control system will continue to be developed with the target of launching it in fiscal 1985.

A spare experimental H-I rocket (two-stage) will continue to be developed to make launching in fiscal 1986 possible and an experimental H-I rocket (three-stage) will also continue to be developed with the target of launching Experimental Test Satellite Type V (ETS-V) in fiscal 1987.

Further, an H-I rocket (three-stage) will be developed with the target of launching Communications Satellite No 3-a (CS-3a) in fiscal 1987 and Communications Satellite No 3-b (CS-3b), etc. in fiscal 1988.

(7) Equipment Improvement for Facilities

Equipment improvement will be made for facilities necessary to develop artificial satellites and rockets, facilities for the launching of artificial satellites and rockets, and facilities necessary for the tracking, etc., of artificial satellites.

(8) Others

These include the advancement of research and development capabilities, the furtherance of international cooperation, actions attending participation in the space development treaty, the acceleration of dissemination and enlightenment activities, the training of space technicians and the improvement of groundwork for space development.

Differences from the Space Development Plan (decided on 14 March 1984) are mainly as follows:

1. Scientific Satellite No 13 (MUSES-A) will be developed with the target of launching it in fiscal 1989 by the M-3SII rocket.
2. Geostationary Meteorological Satellite No 4 (GMS-4) will be developed with the target of launching it in fiscal 1989 by the H-I rocket.
3. Regarding the H-I rocket capable of launching a geostationary satellite of about 550 kg, experimental H-I rockets (two-stage and three-stage) and H-I Rockets (three-stage) Nos 1 and 2 will continue to be developed and H-I Rockets (three stage) Nos 3 and 4 will be developed with the target of

launching Broadcasting Satellite No 3-a (BS-3a) in fiscal 1988 and Geostationary Meteorological Satellite No 4 in fiscal 1989.

4. Research necessary to develop a magnetosphere observing satellite (GEOTAIL) will be conducted.

5. The preliminary design, etc., of experimental modules will be conducted to participate in work at the phase of preliminary design (Phase B) of the U.S.-proposed Space Station Project.

6. Research on the H-II rocket will be conducted to be able to meet the demand for launching large artificial satellites during the 1990's.

2.2 Basic Plan Concerning Space Development

The Space Development Plan (decided on 13 March 1985) was submitted to the prime minister as recommendations whereupon the prime minister in April 1985 formed a Basic Plan Concerning Space Development setting forth the government policy for executing space development.

This basic plan provides for development according to the Space Development Plan and the competent administrative agencies and the National Space Development Agency of Japan (NASDA) will proceed with R&D according to the basic plan.

2.3 Progress of Development

(1) Present State of Agencies Executive Development

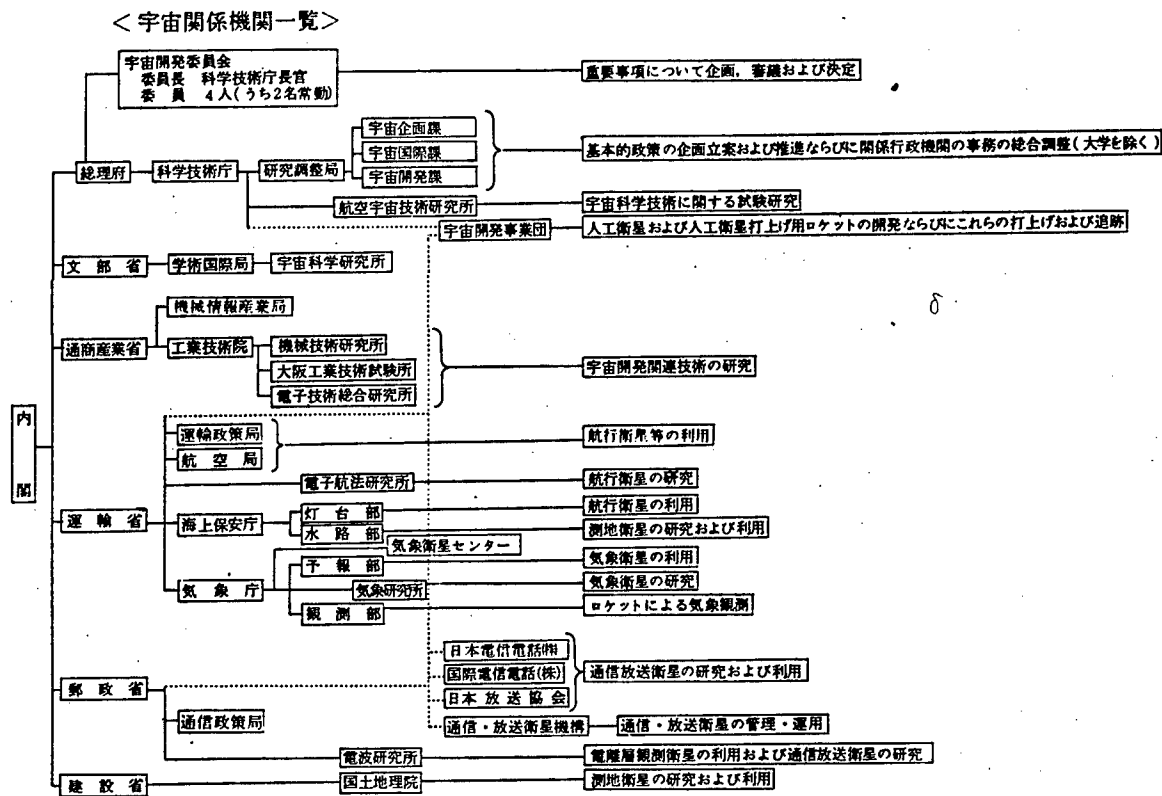
In the space development of Japan, artificial satellites and rockets for launching artificial satellites are being developed by NASDA as the nucleus agency as far as applications are concerned. The Science and Technology Agency, the Ministry of Posts and Telecommunications, the Ministry of Transport, the Ministry of Construction, the Ministry of International Trade and Industry, and others conduct their shares of research for application satellites according to their respective jurisdictions.

In the area of scientific studies, meanwhile, the Institute of Space and Astronautical Science of the Ministry of Education engage in the R&D of scientific satellites and rockets for launching scientific satellites.

The Space Development Committee coordinates the work of these agencies and, at the same time, seeks to advance the nation's space development systematically and comprehensively.

The Japanese agencies executing space development and their assignments are given below.

Chart Showing Space-Related Government Agencies



[key on following page]

Key:

Chart Showing Space-Related Government Agencies

Space Development Agency	
Chairman: Director General, Science and Technology Agency; Members: 4 (including 2 full-timers)	Plans, deliberates, and decides important matters
Cabinet--Prime Minister's Office	
Science and Technology Agency	
Research Coordination Bureau	----Plan, form, and execute basic policies and handle overall coordination of affairs of competent administrative agencies (excluding universities)
Space Planning Section	
Space International Section	----Handles tests and research concerning space science and technology
Space Development	----Develops, launches, and tracks artificial satellites and satellite launching rockets
NASDA	
--Ministry of Education	
Science and International Affairs Bureau	
Institute of Space and Aeronautical Science	
--Ministry of International Trade and Industry	
Machinery and Information Industries Bureau	
Agency of Industrial Science and Technology	
Government Mechanical Engineering Laboratory	----Study techniques relative to space development
Government Industrial Research Institute, Osaka	
Electrotechnical Laboratory	
--Ministry of Transport	
Transportation Policy Bureau	----Use navigation satellites, etc.
Civil Aviation Bureau	
Electronic Navigation Research Institute	----Handles research on navigation satellites
Maritime Safety Agency	
Navigation Aids Department	----Uses navigation satellites
Hydrographic Department	----Studies and uses geodetic satellites
Meteorological Agency	
Meteorological Satellite Center	
Forecast Department	----Uses meteorological satellites
Meteorological Research Institute	----Studies meteorological satellites
Observation Department	----Meteorological observation by means of rockets
--Ministry of Posts and Telecommunications	
Nippon Telegraph and Telephone (NTT)	
Kokusai Denshin Denwa Co. (KDD)	----Study and use communications and broadcasting satellites
Nippon Hoso Kyokai (NHK)	
Telecommunications Satellite Corp. of Japan (TSCJ)	----Controls and operates communications and broadcasting satellites
Communications Policy Bureau	
Radio Research Laboratory	----Uses ionosphere observation satellites and studies communications and broadcasting satellites
--Ministry of Construction	
Geographical Survey Institute	----Studies and uses geodetic satellites

NASDA was established in October 1969 in accordance with the Law for the National Space Development Agency of Japan for the purpose of handling the development, launching and tracking of artificial satellites and satellite-launching rockets comprehensively, systematically and efficiently and thereby contribute to the furtherance of space development and utilization.

(2) State of Development of Rockets and Artificial Satellites

(2)-1 State of Development of Artificial Satellites

① Research in Area of Space Science

Space development for the study of space science was formerly handled by the Institute of Space and Aeronautical Science of Tokyo University but, when it was abolished and the Institute of Space and Astronautical Science was established in April 1981, its studies were taken over by the latter agency.

Scientific Satellite No 1 was initially planned in 1964, based on discussions in the several sessions of a scientific satellite planning symposium held since 1963 with the object of observing the physical phenomena of electric waves, astronomical radiation, corpuscular rays, and others in outer space extensively over a long period. R&D was then conducted by the Institute of Space and Aeronautical Science, Tokyo University. Scientific Satellite No 1 "Shinsei" was successfully launched in September 1971 and carried out such activities as ionospheric plasma observation, cosmic ray observation, and short-wave-zone solar radio observation. Then in August 1972 Scientific Satellite No 2 "Dempa" was also successfully launched. Much data were acquired on such details as ionospheric plasmas, the world distribution of electron densities, and latitudinal changes concerning ion composition. Then came the successful launching of Scientific Satellite No 3 "Taiyo" in February 1975 and studies were conducted on subjects including the interaction between solar radiation and the earth's thermosphere. Though the launching of Scientific Satellite No 4 (CORSA) in February 1976 failed, the launching of Scientific Satellite No 5 "Kyokko" in February 1978, Scientific Satellite No 6 "Jikigen" in September 1978, and Scientific Satellite No 4 "Hakucho" in February 1979 all succeeded and much is being achieved in research on the magnetosphere, the plasmasphere, corpuscular rays, X-ray bursts, etc. Later, Scientific Satellite No 7 "Hinotori" was successfully launched in February 1981 and is being used to observe the solar hard X-ray flare image, the solar corpuscular rays, etc. Then, Scientific Satellites No 8 "Tenma" and No 9 "Ozora" were successfully launched in February 1983 and in February 1984, the former being used to observe X-ray stars, X-ray galaxies, and soft X-ray nebulae and the latter being used to optically study air in the stratosphere and the mesosphere.

In August 1985, Scientific Satellite No 10 "Suisei" was launched for such purposes as observing Halley's comet.

For the future, more scientific satellites up to No 13 are now scheduled to be launched. They are Scientific Satellite No 11 to be launched in fiscal 1986 for such purposes as X-ray astronomical observation and the observation

of X-ray sources of active galaxies, Scientific Satellite No 12 to be launched in fiscal 1988 to observe the accelerating mechanism of auroral grains, auroral emission, etc., and Scientific Satellite No 13 to be launched in fiscal 1989 for such purposes as studying techniques necessary for planet probing.

② Area of Practical Utilization

Space development in the area of practical utilization is handled by NASDA and competent government agencies according to their jurisdictions. Specifically, application satellites are developed by NASDA while the R&D of artificial satellites in such fields as meteorology, communications, broadcasting, and earth observation is handled by different government agencies according to the realities of their respective utilization.

a) Broadcasting Satellite No 2-b (BS-2b)

Basic design was started in fiscal 1981 on this artificial satellite aimed to advance the development of techniques concerning broadcasting satellites and, at the same time, eliminate difficulties in television viewing. Currently, its flight model is being manufactured. Because of time taken to devise countermeasures after the failure of BS-2a, work is being performed with a schedule to launch in winter of fiscal 1985.

b) Geostationary Meteorological Satellite No 4 (GMS-4)

This artificial satellite aimed to improve Japan's meteorological work and develop its techniques concerning meteorological satellites began to be designed in fiscal 1985.

c) Marine Observation Satellite No 1 (MOS-1)

Basic design was started in fiscal 1979 on this artificial satellite aimed not only to observe marine phenomena--mainly the color of the sea surface and temperature--but also to establish techniques common to artificial satellites used for earth observation. At present, its flight model is being manufactured.

d) Communications Satellites No 3 (CS-3a and CS-3b)

Basic design was started in fiscal 1983 on this artificial satellite aimed to take over communications service from CS-2, meet the increasing and diversifying communications needs and develop techniques concerning communications satellites. Its proto-flight model and flight model are being manufactured.

e) Broadcasting Satellites No 3 (BS-3a and BS-3b)

Preliminary design was started in fiscal 1983 on these artificial satellites aimed to take over broadcasting service from BS No 2, meet the increasing and diversifying broadcasting needs and develop techniques concerning broadcasting satellites. Their basic design and the manufacture of their engineering models are scheduled to be started in fiscal 1985.

f) Engineering Test Satellite Type V (ETS-V)

This artificial satellite is aimed to confirm the performance of the experimental H-I rocket (three-stage), establish basic techniques for a geostationary triaxial satellite bus, accumulate Japan's own techniques necessary to develop application satellites of the next generation and also test moving-body communications for such purposes as the marine control of aircraft in the Pacific area, ship communications, navigation aid and search and rescue activities. Its preliminary design and basic design were carried out in fiscal 1983 and at present, its proto-flight model is being manufactured.

g) Earth Resources Satellite No 1 (ERS-1)

Preliminary design was started in fiscal 1984 on this artificial satellite aimed not only to establish active observation techniques but also to conduct observation for the purpose, mainly, of probing for natural resources and for such additional purposes as national land surveys, agriculture, forestry and fisheries, environment protection, disaster control, and the guard of coastal waters. Currently, its equipment is being test-produced.

h) Primary Material Tests

These tests are aimed at enabling Japanese scientists and technicians to experiment with materials aboard Space Shuttle ships, taking advantage of the characteristics of outer space. The design of test systems and the recruiting and selection of scientists and technicians to man the ships were carried out from fiscal 1983 and the present activities include the manufacture of proto-flight models.

i) Space Station

The preliminary design of test modules will begin from fiscal 1985 and study is being made of elementary techniques, etc. in order to participate in work at the phase of preliminary design (Phase B) of the U.S.-proposed Space Station Project.

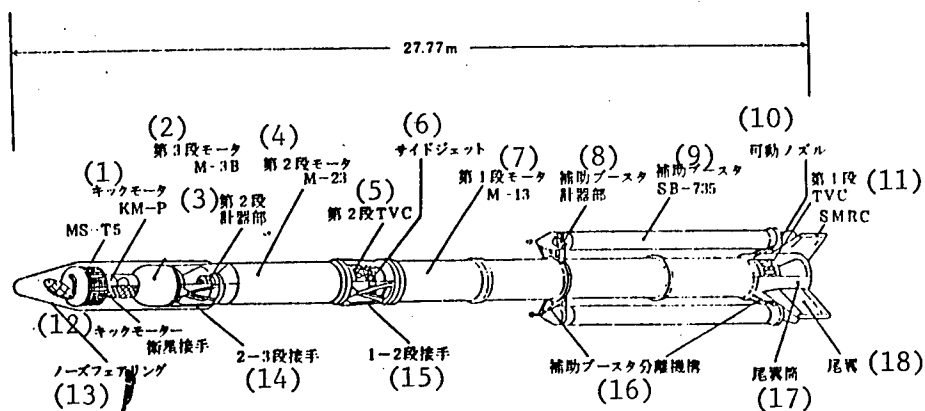


Figure 1. Shape of M-3SII Rocket No 1

Key:

- | | |
|----------------------------------|--|
| 1. Kick motor | 10. Movable nozzle |
| 2. Third-stage motor | 11. First-stage TVC |
| 3. Second-stage instruments | 12. Kick motor satellite joint |
| 4. Second-stage motor | 13. Nose fairing |
| 5. Second-stage TVC | 14. Second/third stage joint |
| 6. Side jet | 15. First/second stage joint |
| 7. First-stage motor | 16. Auxiliary booster separating mechanism |
| 8. Auxiliary booster instruments | 17. Tail cylinder |
| 9. Auxiliary booster | 18. Tail wing |

Table 1. Essential Data of M-3SII Rocket No 1

	First stage	Second stage	Third stage	Kick stage
Length (m)	27.77	13.12	4.68	2.01
Diameter (m)	1.41	1.41	1.50	0.79
Weight of each stage at time of ignition (t)	52.0			0.468
	10.0 (SB)	17.3	4.20	0.138 (SA)
	62.0			0.606
Weight of propellant (t)	27.1			
	8.0 (SB)	10.4	3.28	0.419
	35.1			
Mean thrust* (t)	129			
	67 (SB)	53.4	13.5	3.29
	196			

*vacuum value
 Note: SA: test planetary probe
 SB: auxiliary booster

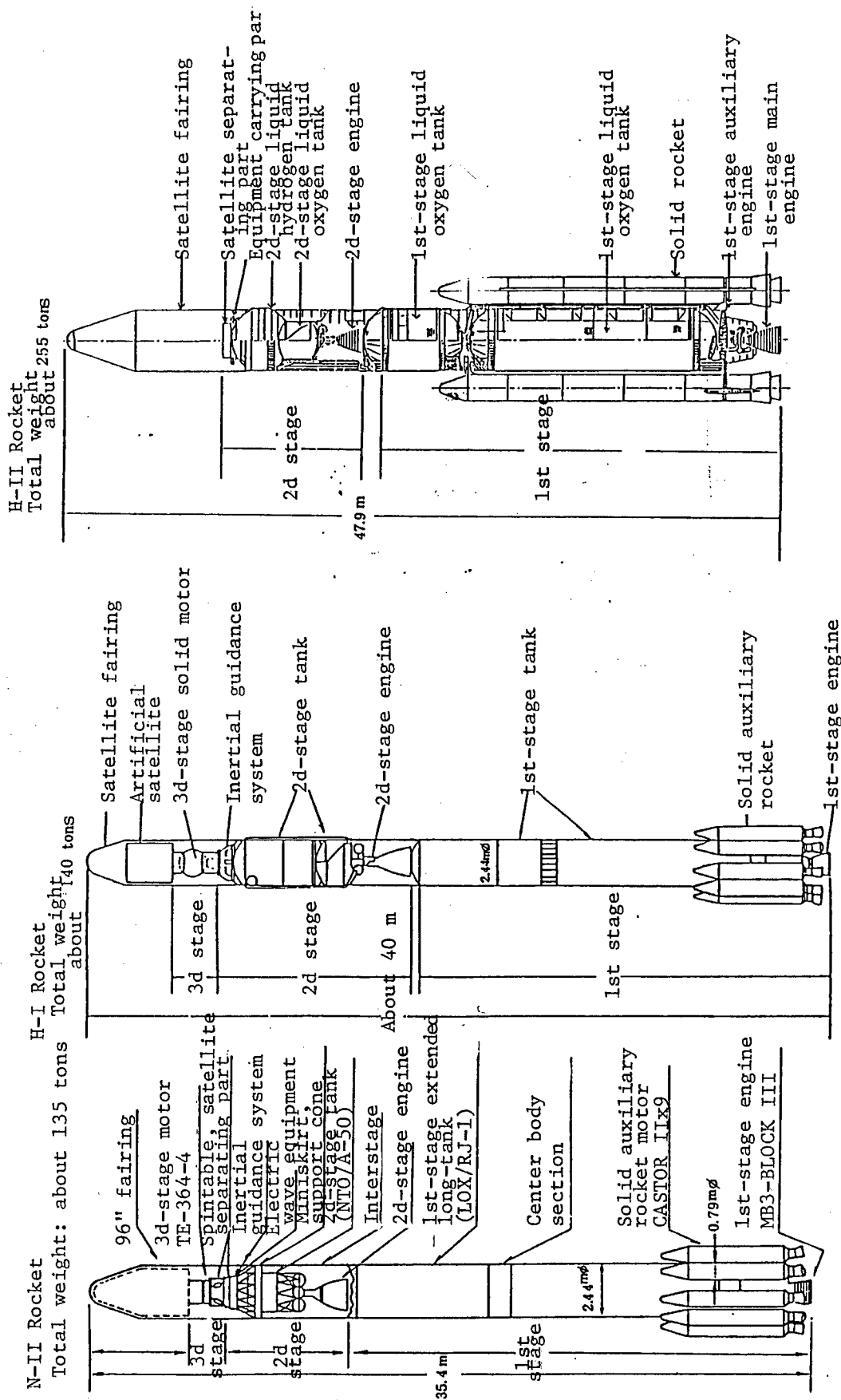


Figure 2. Chart Comparing N-II, H-I, and H-II Rockets

Space Chapter

(2) State of Development of Two Rockets

1) State of Development of the M Rocket

The M-4S rocket was the first in the M rocket system which Tokyo University used to launch scientific satellites. Flight testing using small-scale rockets was begun in 1965 and in 1966 similar testing was begun on the M-4S overall rocket system using an L-4S rocket. Then in February 1970, Japan's first man-made satellite, the "Osumi" was successfully launched using L-4S rocket No 5. Then based on these technological experiences, satellite launching tests using M-4S rockets were begun in September 1970. In February 1971, the "Tansei" test satellite was launched using M-4S Rocket No 2, in September 1971 Scientific Satellite No 1, the "Sensei," was launched using M-4S Rocket No 3, and in August 1972 Scientific Satellite No 2, the "Denpa," was launched using M-4S Rocket No 4.

M-4S rockets consisted of four classes of solid rockets: Class 1 used air stabilization, Classes 2 and 3 used spin stabilization, and Class 4 had attitude control utilizing a system in which spin stabilization was used after determining horizontal in reference to the surface of the earth. In order to improve satellite orbit accuracy, secondary injection thrust vector control (SITVC) was utilized and rocket flight testing was begun in 1969.

Rockets utilizing this SITVC were originally developed as Class 2 and Class 3 M-4SC rockets and it was planned to launch Scientific Satellites Nos 3 and 4 using them. However, because of later R&D, at the prospect of being able to launch the satellites with Class 3-type M-3C rockets using improved Class 2 propellant on the Class 2 and an enlarged Class 4 spherical motor on the last class, it was decided to develop the M-3C rocket in place of the M-4SC rocket.

M-3C No 1 successfully launched the "Tansei No 2" test satellite in February 1974 and then very good results were obtained with M-3C No 2 in the launching of Scientific Satellite No 3, the "Taiyo," in February 1975. However, in February 1976 M-3C No 3 failed in the launching of Scientific Satellite No 4 due to a malfunction in the attitude standard system.

Next developed was the M-3H rocket, an M-3C rocket with an elongated Class 1 with improved propellant. In February 1977 M-3H No 1 successfully launched the "Tansei No 3" test satellite and in September 1978 Scientific Satellite No 6 was successfully launched.

Then the M-3S rocket was developed with total flight control by equipping a Class 1 M-3H rocket with a thrust vector control (TVC) system and solid rocket roll control (SMRC). In February 1980, M-3S No 1 launched the "Tansei No 4" test satellite, in February 1981, No 2 launched Scientific Satellite No 7, the "Hinotori," and in February 1983, Scientific Satellite No 8, the "Tenma," was successfully launched using M-3S No 3.

Since 1981 development has continued on the M-3S II rocket which is an M-3S rocket with improved Class 1 and Class 2 motors and with a modified Class 1 auxiliary rocket. In January 1985, M-3S II No 1 launched the "Sakigake" experimental planetary explorer, and in August 1985, No 2 successfully launched Scientific Satellite No 10, the "Suisei."

2) State of Development of the N Rocket

② State of Development of N-System Rocket

A Space Development Promotion Headquarters was established in 1974 as an annex to the Science and Technology Agency to prepare for the advancement of space development in the area of practical applications but was abolished when NASDA was set up in October 1969 as the nucleus of space development.

A decision was made in 1966 to construct a space center on Tanegashima Island as a regular rocket launching ground and some of its facilities and equipment were completed that year but its subsequent construction and launching tests had to be suspended for the reason of fishery issues. Later, a memorandum was exchanged in 1968 between the government and the local fishermen after a series of negotiations. Thus, the rocket launching tests were resumed as well as the suspended construction of the Tanegashima Space Center.

In 1970, Japan decided to develop an N-1 rocket in an effort to establish the foundation for liquid rocketry, use them widely for the launching of applications and other satellites, and prepare to develop larger rockets.

Trajectory tests had been conducted with the LS-C rocket aimed to develop a liquid rocket to be used for the second stage of the N-rocket and a small rocket (JCR) aimed, among other things, to establish a guidance control technique. Rocket launching tests for up to Machine No 7 of the former type and up to Machine No 10 of the latter type were completed by the winter of fiscal 1973. Then the launching of an experimental rocket was tested for purposes including the trajectory test of the second-stage engine of the N-I rocket as a step important and indispensable to the launching of N-rockets and machines Nos 1 and 2 were successfully launched in, respectively, the summer and the winter of 1974, achieving desired results.

So, the experimental test satellite type I "Kiku" was launched by machine No 1 of the eagerly awaited N-I rocket in the summer of 1975, as scheduled, and the launching of the ionosphere observing satellite "Ume" succeeded that winter. Then in the winter of 1976, the experimental test satellite type II "Kiku 2" was successfully put in a geostationary orbit, making Japan the third country in the world to launch geostationary satellites.

Furthermore, the ionosphere observing satellite "Ume 2" was successfully launched in the winter of fiscal 1977.

When the experimental geostationary communications satellite "Ayame" was launched in February 1979, the attempt to put the satellite in a geostationary

orbit failed due to the malfunctioning of the yaw-weight releasing mechanism in the satellite separating section. But this malfunctioning was later overcome in the February 1980 launching of "Ayame 2."

The development of the N-I rocket was completed with the successful launching of the experimental test satellite type III "Kiku 4" in September 1982 by machine No 6 of the N-I rocket.

With the progress of space development, it had become necessary to launch geostationary meteorological and other satellites too large to be launched by the N-I rocket. So, Japan undertook to develop the N-II rocket capable of launching a geostationary satellite of about 350 kg. This rocket was developed on the basis of the N-I rocket and with a view to reinforcing the solid auxiliary rocket, improving the first-stage propellant tank and increasing the capacity of the second-stage liquid rocket. Then, the experimental test satellite type IV "Kiku 3" was launched by machine No 1 in February 1981, Geostationary Meteorological Satellite No 2 "Himawari" was launched by machine No 2 in August the same year. CS-2a "Sakura 2-a" and the CS-2b "Sakura 2-b" were launched by machine Nos 3 and 4 in February and August 1983. BS-2a "Yuri 2-a" was launched by machine No 5 in January 1984 and GMS-3 "Himawari 3" was launched by machine No 6 in August 1984.

③ State of Development of H-I Rocket

A rocket capable of launching geostationary satellites of 500 kg or more must be developed to launch large artificial satellites whose launching for such purposes as communications, broadcasting, and meteorological observation is scheduled for the period of 1985-1994. For this rocket, efforts have been made to employ an engine using liquid oxygen/liquid hydrogen as a propellant and to develop and basically test a liquid oxygen/liquid hydrogen tank, a solid rocket motor, an inertial guidance system, etc. An H-I rocket capable of putting a satellite of about 550 kg in a geostationary orbit began to be developed in fiscal 1981 on the basis of these results of development research, using for its first stage the first-stage liquid rocket of the N-II rocket and adopting an engine with liquid oxygen/liquid hydrogen as the propellant for the second stage and adopting a large solid motor for the third stage. In this connection, preparations are being made to launch in fiscal 1986 an experimental test satellite (two-stage) aimed at trajectory testing for the second stage and confirmation of the functions of the inertial guidance system and loaded, among other things, with a payload functioning as a geodetic satellite.

④ State of Development of H-II Rocket

To meet the demand for launching large artificial satellites during the 1990's, it is necessary to develop an H-II rocket capable of launching a geostationary satellite of about 2 tons. Elementary studies on this H-II rocket have been continued since fiscal 1983 on the basis of the results of development of the H-I rocket. In 1984, its configuration was prepared and it was decided that it should be a two-stage rocket using liquid oxygen/liquid hydrogen engines plus two solid rockets. In 1985 research aimed at

all-stage development by Japan's own techniques is being conducted, undertaking basic tests on the first-stage engine, the propelling system, the solid rocket booster, satellite fairing, the inertial guidance device and on-board electronic equipment.

2.4 Outline of Fiscal 1985 Space-Related Budget

In the space-related budget for fiscal 1985, the total amount of expenditures for all competent government agencies is about ¥112.5 billion and the total of limit amounts for contracts authorization is about ¥55.2 billion. Compared with the budget for the preceding fiscal year, the rate of increase in expenditure estimates is about -0.04 percent.

The fiscal 1985 budget separately by ministry or agency is generally as follows:

Science and Technology Agency

(1) Research Coordination Bureau

This bureau will handle the operation of the Space Development Committee, surveys necessary to plan the development of application satellites, the furtherance of international cooperation in space science and technology, the overseas dispatch of space development personnel and measures for the fisheries of Tanegashima Island.

(2) Promotion Bureau

This bureau will handle public relations and information concerning space development.

(3) National Aerospace Laboratory

This laboratory will handle not only the launching of BS-2b by the N-II rocket, but also the development of MOS-1, CS-3, BS-3, primary material testing, GMS-4, and the experimental test satellite type V. It will also handle studies to develop Earth Resource Satellite No 1 and work necessary to participate in preliminary design under the U.S. Space Station Project.

Besides, it will continue to develop the N-II rocket and the H-I rocket and start regular research on the H-II rocket. It will improve the Tanegashima Space Center and the Tsukuba Space Center and prepare a rocket and artificial satellite tracking control network.

National Police Agency

This agency will prepare the ground equipment for satellite communications using CS-2.

Ministry of Education

The ministry will launch SS-10 by the M-3SII rocket, continue to develop SS-11, SS-12, and SS-13 and study to develop an atmospheric observation satellite. It will also continue to develop the M-3II rocket and conduct basic research on a liquid oxygen/liquid hydrogen engine.

Ministry of International Trade and Industry

This ministry will handle studies including research on petroleum resource remote detecting technology using an artificial satellite and research on mechanical and electronic techniques concerning space development.

Ministry of Transport

The ministry's Electronic Navigation Research Institute will conduct experimental research concerning satellite navigation. Its Meteorological Agency will commit the development of GMS-4 to NASDA and handle the operation of geostationary meteorological satellites, the reception of cloud photographs from U.S. meteorological satellites and aerological observation by the launching of meteorological observation rockets at Ryori in Iwate Prefecture.

Ministry of Posts and Telecommunications

This ministry will conduct R&D on aeronautical and marine satellite technologies and also carry on research on multibeam for satellite use and studies on the use of the space station. It will also study the techniques of high-precision position measurement by cosmic radio emission.

Ministry of Construction

This ministry will conduct geodetic surveys, using U.S. artificial satellites.

Ministry of Home Affairs

This ministry will improve ground equipment for fire defense and disaster control communications using communications satellites and survey on the use thereof.

3. Future of the Japanese Space Development

3.1 World Trends

With the rapid progress of space development, humanity has succeeded in six manned explorations of the moon from Apollo No 11 in 1969 to Apollo No 17. This success, on the other hand, provided an opportunity to reconsider the space development race having stemmed from superpower rivalry. The United States now takes the position to steadily develop outer space as a place for future human activities and make the development directly serve the purpose of advancing the culture and promoting the welfare of humanity.

The Americans, in forming their post-Apollo space plans, have acted accordingly and are pursuing extensive space activities, such as space utilization, space science, and planet exploration, with the object of turning them to the benefit of humanity.

Central to these plans are the Space Shuttle and Space Lab projects. The Space Shuttle is a new space transport system that permits repeated use and can launch a payload of about 30 tons into a low earth orbit at a low cost.

The Space Lab is what might be called manned space laboratory which will be carried by the Space Shuttle and enable scientists and technicians to conduct various observations and experiments in it for 1 to 4 weeks.

In January 1984, the United States announced a Space Station project proposing to provide the facility for prolonged human habitation on an earth orbit for the purpose of performing experiments and many other missions and appealed to Japan, Europe, Canada, etc., for participation in the project.

The area of practical uses includes communications, meteorology, navigation, geodesy, and earth observation. A glance at American trends in this area shows that with regard to communications, satellite Echo No 1 was launched in 1960. Then application tests were carried out with various communications satellites and the world's first geostationary communications satellite, Syncom No 3, launched in 1964, was successfully used for the television relaying of the Olympic Games in Tokyo to Europe and America.

This American development of satellite communications was the work of, mainly, NASA (National Aeronautics and Space Administration) and AT&T (American Telephone & Telegraph Co.) from about 1958. With the goal of forming a worldwide communications network, the Communications Satellite Corp. (COMSAT) was established in 1963. Then, the U.S. Government and COMSAT actively negotiated with different countries to form a world communications network to which satellites were central. In 1964, a World Commercial Communications Satellite Organization [later known as International Telecommunications Satellite Consortium (Intelsat)] was established with COMSAT at its management. Later, an Intelsat permanent agreement came into effect in February 1973 and the number of Intelsat member nations including Japan reached 108 in March 1984.

Canada launched the world's first domestic-use geostationary communications satellite, Anik A1, in 1972 and is now using Anik C and D series for practical purposes. The Soviet Union, meanwhile, launched communications satellites, such as (Molniya) and (Radoga), for practical uses and formed an "Intersputnik" in the East European countries as an international communications organization similar to Intelsat of the free world. Moreover, it is constructing a global communications network of its own, using geostationary satellites. Besides, there are communications satellite plans in the European countries and ESA's ECS-1 and ECS-2 were launched in June 1983 and August 1984 as communications satellites for European countries. In June 1984 and April 1985, French communication satellites, TELECOM-1A and 1B, were launched.

Summary Table on Space-Related Government Budgets for FY 85

© Contract-resulting-in-treasury-obligation limit amount (in ¥1,000)

Government office	FY 84 budget			FY 85 government budget		
	Space devel- opment related	Space- related	Total	Space devel- opment related	Space- related	Total
Science and Technology Agency	© 55,401,280 85,811,818	--	© 55,401,280 85,811,818	© 48,817,590 91,585,498	--	© 48,817,590 91,585,498
National Police Agency	--	173,632	173,632	--	164,571	164,571
Ministry of Education	© 3,386,000 12,832,404	3,001,476	© 3,386,000 15,833,880	© 3,918,300 6,619,299	4,341,116	© 3,918,300 10,960,415
Ministry of International Trade and Industry	1,467,474	--	1,467,474	3,490,430	--	3,490,430
Ministry of Transport	6,194,955	2,222,541	8,417,496	© 2,023,800 3,026,513	© 424,529 2,297,010	© 2,448,329 5,323,523
Ministry of Posts and Telecommunications	© 437,000 503,700	549,057	© 437,000 1,052,757	447,411	417,391	864,802
Ministry of Construction	--	2,026	2,026	--	2,030	2,030
Ministry of Home Affairs	--	193,684	193,684	--	145,780	145,780
Grand total	© 59,224,280 106,810,351	6,142,416	© 59,224,280 112,952,767	© 54,759,690 105,169,151	© 424,529 7,367,898	© 55,184,219 112,537,049

References: 1. The "space development-related" expenditures comprise space-related expenditures estimated by the Space Development Committee and the "space-related" expenditures comprise what is outside this scope.

2. The amounts given in the table are defrayals from the national treasury. The FY 85 total of space-related expenditures including NASDA revenues other than defrayals from the national treasury is ¥133,756,000,000 (as compared with ¥134,038,000,000 for the previous fiscal year).

In the area of meteorology, the United States launched Tiros No 1 in 1960 and has since launched such satellites as Tiros, Nimbus, ESSA, and Noah. These carry automatic picture transmission (APT) devices which furnish more than 40 countries with data concerning weather forecasts. As for geostationary satellites, it has launched geostationary meteorological satellites SMS and GOES under its Global Atmospheric Research Program (GARP).

Besides the United States, ESA and Japan have launched geostationary satellites and the Soviet Union is planning to launch the same. Meteorological data collected by the Soviet satellite Meteor are being furnished to the Meteorological Data Center in Moscow, thus contributing to weather forecasting.

In the area of navigation, the launching of such series as Transit and NAVSAT satellites has continued since the launching of the first Transit satellite in 1960. Regarding maritime satellites, the International Marine Satellite Organization (INMARSAT), an international organization for an international maritime satellite system, was established by a treaty and began to operate in February 1982. In March 1984, 38 countries including Japan were members of the INMARSAT.

In the area of geodesy, several types of satellites have been launched since (Pagios) launched in 1962 and are producing results.

In the area of earth observation, the United States, which launched an experimental earth resources exploring satellite, Landsat No 1, in July 1973, launched Landsat No 5 in March 1984. Countries including Japan have successfully participated in the analysis of data gained from it. France is planning to launch its earth observing satellite, SPOT.

The world's leading space developing nations, notably the United States, the Soviet Union, and nations of Europe, are all making active moves toward the practical utilization of outer space. The time of its practical use seems to have come in the form of international organization and unification in not only communications but also meteorology and navigation.

3.2 Future of the Japanese Space Development

Regarding the future of Japanese space development, the Space Development Committee, as stated already, set the General Policy on Space Development, clarifying the basic framework and the direction of the nation's space development for the next 15 years or so. It is outlined below.

(1) Basics of the Space Development Policy

In executing its space development, Japan will stress the following ideas:

- ① The basic principle of the Japanese space development is to meet extensive and diverse social needs adequately and effectively and the target of the overall development is to create a space system which can be easily used by types who want to use it.

Further, in setting individual programs, their necessity, urgency, and economy will be thoroughly studied and the programs will be executed systematically, effectively, and according to the nation's ability and circumstances.

- ② Efforts will be made to establish and maintain technological capabilities of Japan's own so that the nation can execute its space development activities accurately, freely, and stably.
- ③ The Japanese space development will be harmonized with the space developing activities of the rest of the world insofar as possible and Japan will take an active part in the Space Station and other projects insofar as possible.

For this purpose, Japan, while using Japanese rockets, will also use shuttle and other services, if necessary, to carry out space developing activities of the world level, as a whole, and contribute its due share to international activities and cooperate in them with the results of its space development.

(2) Main Targets of Space Development Activities

In Japanese space development, emphasis will be laid on the following targets:

- ① In space developing activities concerning scientific research, Japan will maintain its sciences at the world level and duly contribute to the intellectual progress of the human society.

In the area of practical applications, efforts will be made not only to establish technical stability in segments having so far been undertaken but also to aggressively develop new applications. At the same time, Japan will seek to advance its techniques concerning rockets and artificial satellites and expand its application capacity with a view, mainly, to reducing burdens on the ground side and making space missions more sophisticated and less expensive.

(3) Series To Be Carried Out by Japan During Next 15 Years

- ① Space Developing Activities in Area of Communications

In the area of communications, Japan will seek to produce for itself satellites and rockets covered by existing plans, develop techniques on its own and improve its satellite developing techniques and, at the same time, carry out a fixed communications satellite series, a broadcasting satellite series, and a moving-body communications and navigation satellite series as applications projects.

- ② Space Developing Activities in Area of Observation

In the area of observation, Japan will carry out an astronomical observation series and an around-the-earth scientific observation series which consist

of conducting the world's top-level activities at each point of time in order to develop Japanese sciences, a sea and land area observation satellite series aimed to establish observational technology based on Japan's own techniques and apply this technology for practical utilization, an electro-magnetosphere and solid earth observation satellite series comprised mainly of the application of these and a meteorological satellite series aimed to further domestic production under the existing plans, sophisticate it and apply it to practical utilization.

Japan will also carry out a moon and planet exploration series concerned mainly with the moon and earth-like planets as a summation of techniques developed around the earth and as a springboard for a new leap in space technology.

③ Space Developing Activities in Area of Space Experiments

In the area of space experiments taking advantage of the environmental conditions of outer space, scientific and engineering experiments will be conducted. In addition, a material test series and a life science test series will be conducted as typical of this area and as something to become industrially important in the future.

④ Space Developing Activities in Area of Techniques Common to Artificial Satellite Systems

Artificial satellite techniques necessary to carry on activities in all areas will be made standard and systematic and on-board equipment will be made increasingly sophisticated. At the same time, a "shuttle laboratory" will be developed and ways and means will be devised to make it possible to conduct various activities under manned support for which Japan will have to depend on the United States, etc., for some time.

⑤ Space Developing Activities in Area of Techniques Common to Transport Systems

Japan will possess three types of rockets: M-rocket using a solid propellant, N-system rocket using a petroleum-type fuel and H-system rocket using a liquid hydrogen fuel. They will be developed as typical machines corresponding to their respective payloads. No other new types will be developed. Rather, the plan will stress expanding the applied capacities of the rockets.

The M-rocket will continue to be used in the future for smaller missions, the N-system rocket will be the main type pending the use of the H-I rocket and the H-I rocket will be developed and used as the nation's main type for the period from 1985. Further, the H-II rocket capable of launching an artificial satellite of about 2 tons into a geostationary orbit will continue to be developed to meet the demand for launching large artificial satellites in the 1990's.

(4) Setup for Executing Space Development

To accomplish the abovementioned various activities, it is necessary for a single national development setup to be prepared so that R&D may be conducted comprehensively and efficiently according to a firmly established plan.

The various agencies, therefore, must improve their respective structures in accordance with their roles.

Here, to proceed with space development based on the nation's own techniques, there must be a structure where the relation of effective and smooth continuity between research, development, and utilization can be assured and the results achieved by scientific satellites and application satellites can be mutually exchanged. For this purpose, the capabilities of agencies handling precedent research and utilization research and the development sector of NASDA will be improved furthermore and an experimental research center open to joint research, etc., by competent agencies will be prepared so that the nation, as a whole, can efficiently execute the plan.

In carrying out actual programs, competent agencies will undertake to do their shares or cooperate, as required, in their capacities as participants in these national projects.

(5) Improvement of Foundation for Space Development

The courses and frameworks of related measures necessary to realize the abovementioned activities effectively are as follows:

- ① The government's technical capabilities will be improved by intensifying research conducted by universities and national laboratories and research institutes in response to the space development series and, at the same time, the technical capabilities of the private industries will be strengthened by discovering and developing manufacturers with special techniques, systematizing their research and equipment, standardizing their techniques, transferring their techniques and furthering their joint R&D.
- ② Development will be executed efficiently by unifying missions, launching a number of satellites simultaneously and concentrating facilities and equipment.
- ③ Efforts will be made to stabilize production, reduce production costs and increase the number of direct beneficiaries.
- ④ International joint projects, multinational cooperation and cooperation with developing nations will be stepped up. With regard to the U.S.-proposed Space Station project particularly, Japan will study to be able to respond to it as a major international joint project to be tackled in the immediate future.

⑤ Efforts will be made to urge the establishment of international rules with the object of rationalizing space developing activities. And domestically, measures for such purposes as the assurance of safety will be stepped up.

⑥ Efforts will be made to improve such environments favorable for the execution of space development as dissemination and enlightenment, the training of personnel and the facilitation of information distribution.

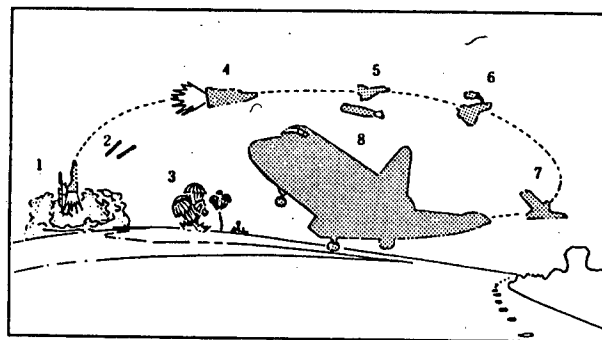
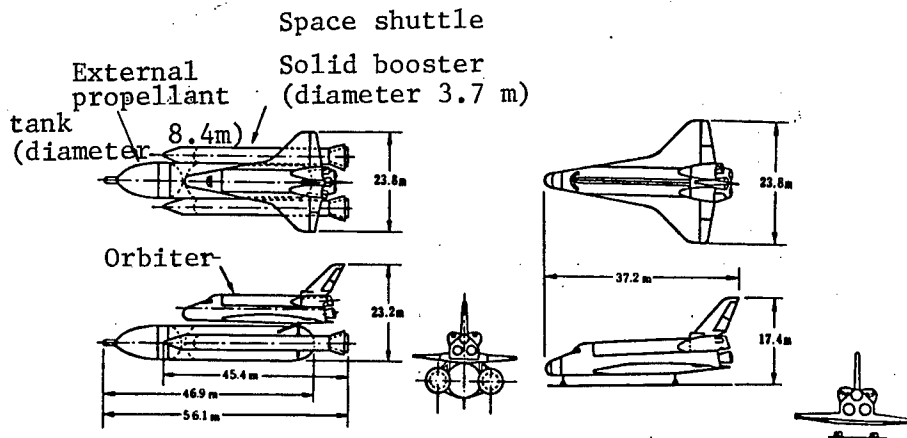


Illustration of Space Shuttle Flight

Key:

1. Launching: The main engine and the solid booster are caused to operate simultaneously
2. Detaching of solid booster: Altitude: about 45 km
3. Recovery of booster: The booster is caused to descend onto the sea by parachute and recovered by ship for repeated use.
4. Continued flight of orbiter
5. The external propellant tank is detached by retromotor after arrival in orbit.
6. Execution of mission (1 to 4 weeks)
7. Reentry into the atmosphere: Slide
8. Landing onto a runway provided in the vicinity of the place of launching: The orbiter is used again.

Table 2. Table Comparing Essential Data of N-II, H-I, and H-II Rockets

Item		N-II rocket	H-I rocket	H-II rocket
All stages	Length	35.4 m	About 40 m	47.9 m
	Diameter	2.44 m	About 2.44 m	4.0 m
	Total weight (excluding satellite and satellite separating part)	134.7 tons	About 140 tons	255.3 tons (including satellite separating part)
	Launching capacity	Geostationary satellite of about 350 kg (including apogee motor case)	Geostationary satellite of about 550 kg (including apogee motor case)	Geostationary satellite of about 2 tons
1st stage	Propellant	LOX (liquid oxygen)/RJ-1 (kerosene)	LOX (liquid oxygen)/RJ-1 (kerosene)	LOX (liquid oxygen)/LH ₂ (liquid hydrogen)
	Weight of propellant	81 tons	81.4 tons	85.0 tons
	Mean thrust	77 tons	78.0 tons (on sea surface)	93.0 tons (on sea surface)
	Specific impulse	249 tons	249 seconds (on sea surface)	449 seconds (on sea surface)
Solid auxiliary rocket	Weight	86 tons (including interstage)	86.3 tons	97.0 tons
	Propellant	Solid	Polybutadiene solid propellant	Polybutadiene solid propellant
	Weight of propellant	3.75 tons each x 9	3.75 tons each x 9	59 tons each x 2
	Mean thrust	23.7 tons each x 9 (on sea surface)	238 seconds (on sea surface) 23.7 tons (on sea surface; each)	160 tons (on sea surface; each x 2)
2d stage	Weight	4.5 tons each x 9	4.47 tons each x 9	69 tons each x 2
	Propellant	Dinitrogen tetra-oxide/A-50	LOX (liquid oxygen)/LH ₂ (liquid hydrogen)	LOX (liquid oxygen)/LH ₂ (liquid hydrogen)
	Weight of propellant	6.0 tons (maximum)	8.65 tons	13.0 tons
	Mean thrust	4.4 tons (vacuum)	10.5 tons (in vacuum)	10.5 tons (in vacuum)
3d stage	Specific impulse	314 seconds (vacuum)	445 seconds (in vacuum)	447.8 seconds (in vacuum)
	Weight	6.75 tons	10.5 tons	15.6 tons
	Propellant	Solid	Polybutadiene composite solid propellant	
	Weight of propellant	1.05 tons	1.9 tons	
Satellite fairing	Mean thrust	6.8 tons (vacuum) (TE-364-4)	8.5 tons (in vacuum) 288 seconds (in vacuum) 2.2 tons	
Guidance formula		DIGS (delta inertial guidance system)	Inertial guidance	Inertial guidance (strapdown formula)

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AEROSPACE SCIENCES

DEVELOPMENT, STATUS, PROSPECTS OF MARINE OBSERVATION SATELLITE

Tokyo KAIYO KAGAKU in Japanese Aug 85 pp 510-516

[Article by Kohei Arai, Earth Observation Center, National Space Development Agency of Japan (NASDA): "Symposium: Satellite Oceanography--Satellite Data Utilization Techniques/10; On Marine Observation Satellite No 1 (MOS-1)"]

[Text] This article describes the purpose for the development of the Marine Observation Satellite No 1 (MOS-1), the first Japanese earth observation satellite, its present condition, its future plan, its system, its observation principle and its possibilities for observation.

1. Mission

The purpose of MOS-1 is not only to observe marine phenomena, mainly the color of the sea and its temperature, but also to establish basic techniques common to earth observation satellites. The mission to be accomplished after its launching comprises the following:

- (1) to establish the basic techniques of earth observation satellites;
- (2) to develop a visual near infrared radiometer (MESSR), a visual thermal infrared radiometer (VTIR), and a microwave radiometer (MSR), ascertain their functions and capacities, and experimentally observe the entire earth, mainly its seas, with these instruments;
- (3) to basically test a data collecting system (DCS);
- (4) to acquire the technique of placing in a solar synchronous orbit;
- (5) to acquire the techniques of tracking control in solar synchronous orbit; and
- (6) to acquire the technique of operating an earth observation satellite.

2. Outline of the Earth Observation System Using MOS-1

The earth observation system using MOS-1 (MOS-1 system) is composed of space and ground segments. The former consists of the satellite itself, which includes observational and bus equipment, while the latter comprises launching

tracking control, operation control, data acquisition and processing, and utilization systems.

(1) Space segment

Orbit

MOS-1 is scheduled to be launched into a solar synchronous quasitropical orbit with a descending node mean local solar time of 10~11 hours and a tropical day number of 17 so that it can be observed periodically at nearly the same time. It will make 14 rounds a day with an orbital cycle of about 103 minutes, at an altitude of about 909 km and an orbit inclination of 99 degrees. Figure 1 shows the per-day locus of its orbit.

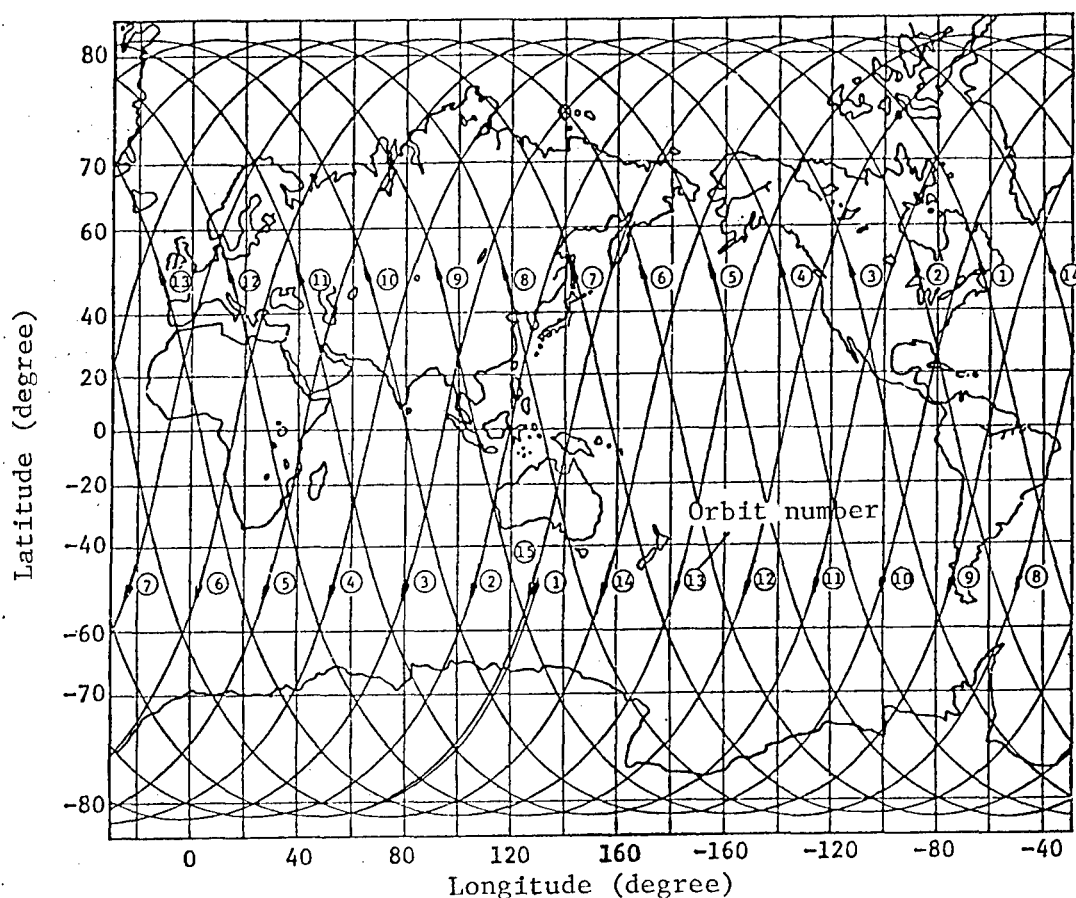


Figure 1. Orbit Locus of MOS-1 per Day

Mission instruments

MOS-1 will carry observational instruments: MESSR, VTIR, and MSR and a DCS relay as mission instruments. The main data of these instruments are consolidated in Table 1.

Table 1. Main Data of MOS-1 Mission Instruments

Characteristics of MESSR

Item	Capacity
Wavelength (μm)	0.51 - 0.59 (band 1) 0.61 - 0.60 (band 2) 0.72 - 0.80 (band 3) 0.80 - 1.10 (band 4)
Instantaneous angle of field of view (μ rad)	54.7 ± 5.0
Scanning width (km)	100
Scanning formula	Electronic scanning
Optical system	Refraction type
Detector	2,048 element CCD
S/N	39 dB - 15 dB 64 (6 bits)
Scanning period (msec)	7.6
Data rate (Mbit/sec)	9
Power consumption (W)	89.8
Weight (kg)	70.7

Characteristics of VTIR

Item	Capacity	
Wavelength (μm)	Visible	Infrared
	0.5 - 0.7	6.0 - 7.0 10.5 - 11.5 11.5 - 12.5
Instantaneous angle of field of view (mrad)	1 ± 0.1	3 ± 0.3
Observation width (km)	1,500	
Scanning formula	Mechanical	
Rotating period	1/7.3 sec	
Detector	Si-PIN diode	HgCdTe
Optical system	Richey	Chretien
S/N	> 55 db (albedo = 80 percent)	--

[continued]

[Table 1 continued]

[Continuation of Characteristics of VTIR]

Item	Capacity	
	Visible	Infrared
NEAT	--	> 0.5K (at 300K)
Quantization level	256 (8 bits)	256 (8 bits)
Data rate (Mbit/sec)	0.8	
Power consumption (W)	46.1	
Weight (kg)	30.2	

Characteristics of MSR

Item	Capacity	
	Visible	Infrared
Frequency (GHz)	23.8 ± 0.2	31.4 ± 0.25
Beamwidth	1.89° ± 0.19°	1.31° ± 0.13°
Integrating time (msec)	10 & 47	10 & 47
Observation width (km)	317	
Scanning formula	Mechanical (conical scan)	
Dynamic range	30 - 330K	
Antenna	Offset cassegrain	
Receiver	Dicke	Dicke
Polarization	Horizontal	Vertical
Receiving sensitivity	<1K (target) (at 300K, inte- grating time 47msec.1σvalue)	<1K (target) (at 300K inte- grating time 47msec.1σvalue)
Observation period	3.2 sec	
Quantization level	1,024 (10 bits)	
Data rate	2 Kbits/sec	
Power consumption (W)	48.6	
Weight (kg)	54.0	

[continued]

[Table 1 continued]

Characteristics of DCS

Item		Capacity
DCP ↓ Satellite	Frequency	401.5MHz \pm 4.0KHz
	Modulation formula	PCM-PSK
	Bit rate	400 bps
	Effective radiation power	35 dBm
	Emitting formula	A burst of about a second is emitted every 60 seconds
Relay	Relay bandwidth	90KHz \pm 10KHz
	Formula	Phase remodulating formula of random access type
	Locally oscillated frequency stability	Short term 1×10^{-9} /sec Medium term 1×10^{-8} /10 min Long term 1×10^{-6} /year
Satellite ↓ ground	Frequency	1702.4848 MHz
	Remodulating formula	PM

MESSR is a radiometer that, in scanning, uses a clock to read a charge which has stored through photoelectric conversion. Two systems are attached to the satellite slanted so that their scanning widths somewhat overlap each other. When both are caused to operate simultaneously, the observation width is 200 km.

VTIR is a radiometer that scans with a motor driven mirror. When the scanning mirror does not face the ground surface, it observes radiation from the blackbody in the interior and from the space and calibration is made, based on data from this observation. Also, heat is released into the space with a radiation cooler so as to hold the detector to less than 110 K.

MSR is a conical-scan type radiometer that turns an offset cassegrain antenna commonly used for two frequencies at about 18.75 (rpm). It uses half of the time taken by the antenna to make a round for observation and uses the remaining half to calibrate low and high temperatures.

The relay for DCS receives data measured at buoys, etc. floating on the sea and transmits them back to a ground station. It can also determine the position of the buoy, etc. by measuring the Doppler frequency of the wave received. A signal (400 MHz) received from a DCP (data collection platform) is converted into a 200 KHz IF signal and transmitted to the ground by a 1.7 GHz band after undergoing phase modulation. In a relay of this type, the frequency stability of the receiving local oscillator affects accuracy in determining a position. Thus, the relay is so composed that a single original oscillator controls both the receiving local oscillation frequency and the transmitting carrier frequency.

Operating mode

The operating mode of each measuring instrument including its daytime and nighttime operation, gains, calibration, and other details is shown in Table 2.

Table 2. Operation Modes of Observational Instruments for Daytime (Sunshine Hours)

Observational instrument	Mode	A	B	C	D	E	F	G	H
MESSR		o	o	o		o			oo
VTIR		o	o		o		o		
MSR		o		o	o			o	

(Note) H mode is for simultaneous observation by two MESSR systems (not used at operational mode).

Table 2 (continued) Gain, Calibration, and Other Modes

	Gain mode	Calibration mode	Other modes
MESSR	High gain Normal gain	Voltage calibration	Shaded hour (night) operation (K mode)
VTIR	16 steps 32 dB 2 dB step	Voltage calibration	Radial cooler/heater ON mode Space/blackbody clamp
MSR	AGC/MGC 128 steps 0.25 dB step	Step Attenuator (Combination of seven attenuations)	Sky horn mode Standard noise mode

AGC: automatic gain control

MGC: manual gain control

Table 2 (continued) Nighttime (Shaded Hour) Operation Modes of Observational Instruments

Observational instrument	Mode	I	J	K
MESSR				cal
VTIR		o		
MSR			o	

(Note 1) cal: MESSR calibration mode

(Note 2) Observing time: less than 15 minutes per round

(Note 3) DCS relay: operable at all times

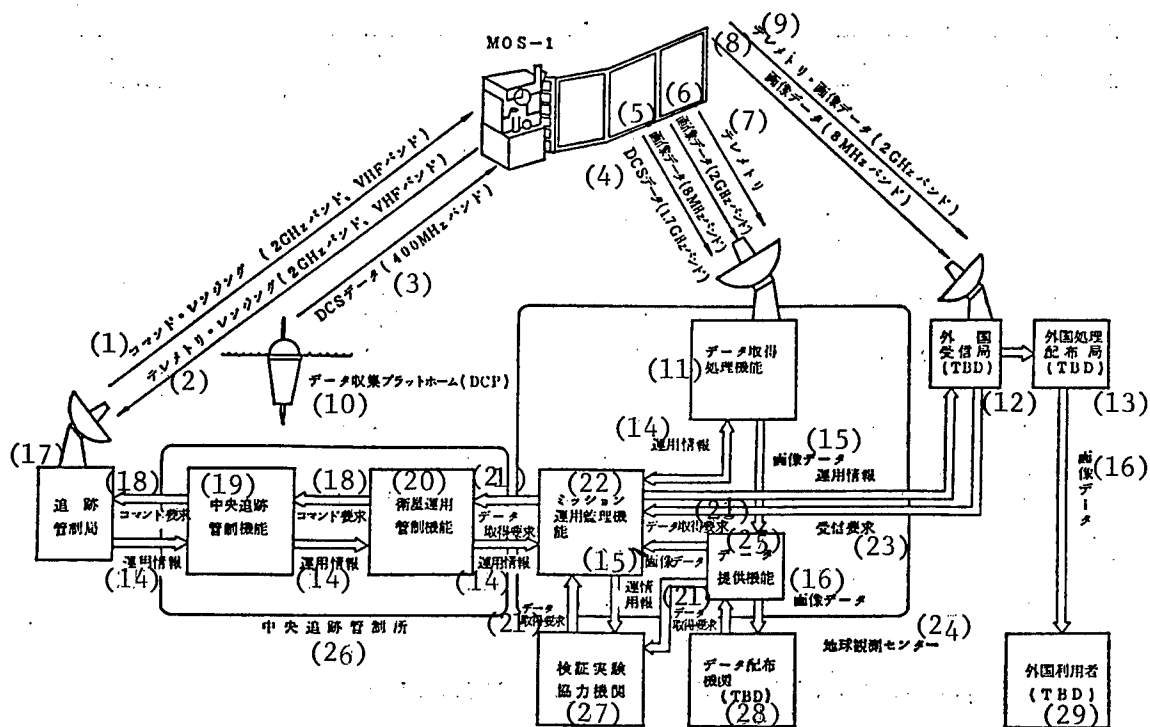


Figure 2. MOS-1 Functions, Mainly the Operation System

Key:

- | | |
|---|--|
| 1. Command range (2 GHz band, VHF band) | 16. Image data |
| 2. Telemetry range (2 GHz band, VHF band) | 17. Tracking control station |
| 3. DCS data (400 MHz band) | 18. Command requirement |
| 4. DCS data (1.7 GHz band) | 19. Central tracking control function |
| 5. Image data (8 MHz band) | 20. Satellite operation control function |
| 6. Image data (2 GHz band) | 21. Data acquisition requirement |
| 7. Telemetry | 22. Mission operation control function |
| 8. Image data (8 MHz band) | 23. Reception requirement |
| 9. Telemetry-image data (2 GHz band) | 24. Earth Observation Center |
| 10. Data collecting platform (DCP) | 25. Data furnishing function |
| 11. Data acquiring and processing function | 26. Central tracking control station |
| 12. Foreign receiving station (TBD) | 27. Agency cooperating in verifying test |
| 13. Foreign processing and distribution station (TBD) | 28. Data distributing agency |
| 14. Operation information | 29. Foreign user (TBD) |
| 15. Image data operation information | |

There are normal and high MESSR gain modes. In the latter mode, quantized noise at a low radial brightness, as on the sea surface, is one-third that for the former mode. As methods of calibration, electronic voltage calibration by standard voltage and nighttime calibration by the above-sea-condition are available as functions.

Sixteen-step switching is possible with VTIR gain modes. Also, voltage calibration as in the case of MESSR is possible. Further, there are clamp modes in space and blackbody temperatures where calibration accuracy is high in the low-temperature zone and the general zone of ordinary temperature. The likely decline of cooling efficiency of the radial cooler due to contamination under space environments can be coped with by using a built-in heater.

MSR gains can be controlled both automatically and manually. In manual control, attenuation can be determined by the combination of seven step attenuators: 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, and 16.0 dB. In automatic control, attenuation is controlled so that, when step-up attenuators operated during the period of calibration modes on the basis of the sky horn output voltage value, this output can equal the standard voltage. Two points are used for calibration, they are: sky horn to acquire the noise temperature (about 2.7 K) of the space and standard noise source of the nonreflection terminal (about 300 K) monitoring temperature.

(2) Ground segment

Figure 2 shows the functions of MOS-1, mainly its operation system.

Tracking control system

The tracking control of MOS-1 is to be handled by a central tracking control station and three tracking control stations. The central tracking control station will determine the orbit of the satellite, control the orbit and process data indicating the condition of the satellite while the other tracking control stations will be charged with distance measurement, command transmission and telemetry data reception, etc.

Operation control system

Operation control comprises satellite operation control and mission operation control. The mission operation control plans the operation of mission instruments, taking into consideration the data acquisition and processing requirement aimed to evaluate the MOS-1 system and similar requirements from foreign agencies including overseas stations. The satellite operation control will check with conditions restricting the thermal and electric-power actions of the satellite according to this plan and finalize the plan with mutual coordination.

System for data acquisition and processing, etc.

This system will, acting under the operation control plan, receive, record, process, photograph, examine, evaluate, preserve, retrieve, and furnish

telemetry, image, calibration, and DCS data transmitted from MOS-1. At present the output results in Table 3 are anticipated.

Table 3. Format on Types of MOS-1 Data Processing and Results

Observational Item instrument	MESSR	VTIR	MSR	
Correction mode	Level 0-4	Level 0-4	Level 0-4	
Map projection	UTM/SOM	Polar stereograph- ic (PS) Lambert Conformal Conic (LCC) UTM	Same as left	
Resampling	Nearest neighbor method (NN) Bilinear method (BL) Cubic convolution (CC)	Same as left	Same as left	
C C T	Recording unit	90 x 100 km 4 bands	5,000 x 1,500 km 4 bands	5,000 x 317 km 2 frequencies, 2 integrating times
	Record form	World standard format	World standard format	World standard format
	Data and record density	BSQ/BIL 6250/1600 BPI	BSQ/BIL 6250/1600 BPI	BSQ/BIL 1600 BPI
	Number of tracks	9	9	9
	Number per scene	1 (6250 BPI) 1 (1600 BPI)	1 (6250 BPI) 2 (1600 BPI)	1
F i l m	Recording unit	90 x 100 km	5,000 x 1,500 km	5,000 x 317 km
	Format	UTM: latitude and longitude indi- cated SOM: distance indicated	UTM: latitude and longitude indi- cated PS, LCC: "	UTM: latitude and longitude indi- cated PS, LCC: "
	Film size	70 mm (240 mm)	240 mm	70 mm

Remarks: Results of DCS comprise CCT and line printer recording observed DCP data, ID number, and the position and velocity of DCP.

3. Present Development and Operation Plans

The past and present development of the MOS-1 system and its operation schedule are shown in Table 4. The flight models of observational instruments have already been integrated into that of the satellite itself and are going to be brought to the Tanegashima Space Center after tests and prepared

[illegible]

PM : Prototype model	FM : Flight model	Note: May be subject to change as development progresses.
CDR: Critical design review	PDR: Preliminary design review	
EM : Engineering model	BBM: Breadboard model	
PM : Preliminary design review		

CDR: Critical design review

there for launching. The ground segment is now being manufactured and tests will be completed before the launching. The first 3 months after the launching is the period for mission check to evaluate and confirm part of the functions and performance of the satellite system and the ground system. The next 6 months or so will be spent on checking performance of the MOS-1 system. A subsequent period of about 15 months a test operation is scheduled to evaluate the MOS-1 system. The furnishing of data will begin at test operation stage.

4. Principles and Possibilities of Observation

(1) MESSR Data

An object on the ground, which constitutes the objective of observation, shows sunlight reflection characteristic of its own according to its physical and chemical characteristics and the conditions of its surface. It is, therefore, possible to see the conditions of the ground surface by detecting the reflection energy and wavelength characteristics of sunlight reflected by the ground surface.

In outer space, the spectrum distribution of solar radiation energy can be approximately by that of 5,900 K blackbody radiation. When this passes through the atmosphere, it is absorbed and scattered by atmosphere components, floating matter, vapors, etc. There are several wavelength areas known as "windows of the atmosphere" (Figure 3) which are relatively free from these effects.

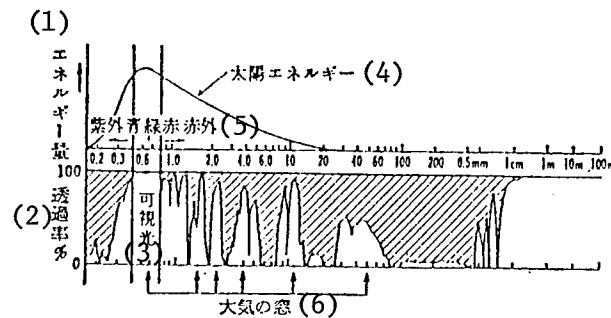


Figure 3. Spectral Transmission Characteristics of Atmosphere

Key:

- | | |
|-----------------------------|------------------------------------|
| 1. Amount of energy 100 | 4. Solar energy |
| 2. Transmissivity (percent) | 5. Ultraviolet blue green infrared |
| 3. Visible light | 6. Windows of atmosphere |

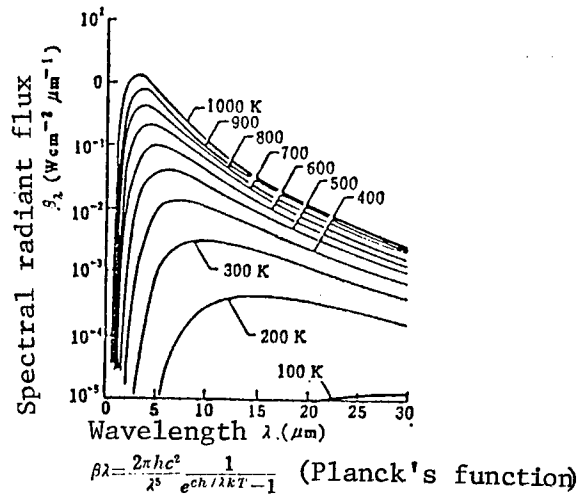
For MESSR, four wavelength areas (bands) are selected from among the windows of the atmosphere in the visible near infrared domain and the fields of utilization assumed for each band are as indicated in Table 5.

Table 5. Fields of Utilization of MESSR

Item Band	Wavelength area	Sensitivity characteristics	Assumed field of utilization
Band 1	0.51-0.59 μm (green)	Peak in visible light green reflection of vegetation (chlorophyll scatter zone) Great underwater transmission)	Sea: Coastal sea water, lake water, red tide Coastal waters submarine topography (when transparency is great) Land: Evaluation of vitality of vegetation, snow cover distribution, distribution of ashes from volcanic eruption, land utilization
Band 2	0.61-0.69 μm (red)	Identification of vegetation (chlorophyll absorbing zone)	Sea: Coastal sea water, lake water, red tide, eddies Land: Land utilization, transport network, geological structure, identification of vegetation, snow cover distribution, agriculture and forestry, distribution of ashes from volcanic eruption
Band 3	0.72-0.80 μm (near infrared)	Great haze transmission	Land: Surface water, bogs and water resources, agriculture and forestry, geological structure
Band 4	0.80-1.1 μm (near infrared)	Biomass survey (distinction between waters and land)	Sea: Ice distribution, shore, channels Land: Surface water, preparation of maps with topography, flood areas, agriculture and forestry, lakes and swamps, forest fires

(2) VTIR Data

The earth can be regarded as a blackbody of about 245 K because it maintains balance as its semiglobe receives 5,900 K solar radiation and the entire globe radiates heat. As indicated in Figure 4, the peak in the spectrum of blackbody radiation energy at this temperature is the 10 μm zone and, as in Figure 3, it forms a window of the atmosphere. It is, therefore, possible to presume temperature on the ground surface by measuring radiation in this band.



Here, $\beta\lambda$: per unit-wavelength-width volume of energy radiated from unit surface area of blackbody in unit time ($\text{W cm}^{-2}\text{cm}^{-1}$)
 λ : wavelength (cm)
 T : absolute temperature (K)
 h : Planck's constant ($6.626 \times 10^{-34} \text{ Wsec}^2$)
 c : light velocity ($2.998 \times 10^{10} \text{ cm sec}^{-1}$)
 k : Boltzmann's constant ($1.380 \times 10^{-23} \text{ Wsec K}^{-1}$)

Figure 4. Blackbody Radiation

Radiation intensity I_x at wavelength λ observed by the satellite can be expressed by

$$I_x = \varepsilon_x \beta_x(T_s) \tau_x(P_s) - \int_0^{P_s} \beta_x(T) \frac{\partial \tau_x(P)}{\partial P} dP + (1 - \varepsilon_x) R_x \tau_x(P_s) \quad (1)$$

Here, ε_x is emissivity on the sea surface, $\beta_x(T)$ is the Planck's function at temperature T , $\tau_x(P)$ is the atmosphere transmission function for the distance from the satellite to atmospheric pressure p , the first and second terms represent contributions from the sea surface and the atmosphere and the third term represents the component of atmosphere radiation reflected by the sea surface. If these second and third terms are either so small that they can be ignored or correctable, sea surface water temperature T_s can be observed from I_x .

Table 6 shows the wavelength areas and assumed fields of utilization of VTIR. In it, the $6 \mu\text{m}$ zone is a nearly 100 percent H_2O absorbing area where the peak of $\partial \tau_x(P) / \partial P$ (weight function) in expression (1) is at a height of about 400 mb (7-8 km). So, it is possible to detect the upper layer steam distribution and thin cirrus clouds. In bands 3 and 4 into which the $10 \mu\text{m}$ zone is divided, steam distribution can be corrected to an extent, taking advantage of the fact that the rates of steam contribution are different there.

(3) MSR Data

If $ch/\lambda KT$ is sufficiently smaller than 1, namely, if the wavelength is in the microwave zone (1-100 GHz), the Planck's function can be rewritten in Rayleigh-Jeans law.

$$\beta_w = 2\pi CKT/\lambda^4 (W \cdot m^{-2} \cdot \mu m^{-1}) \quad (2)$$

Namely, the microwave radiation is in proportion to temperature. Expression (2) is for the blackbody (emissivity $\epsilon = 1$) but, since ordinary substances are not blackbodies, the product of multiplication of physical temperature T by emissivity ϵ is defined and used as luminance temperature. ϵ varies with the physicochemical properties (surface temperature, roughness, moisture content, etc.) of the object and observation parameters (frequency, angle of incidence, polarization, etc.) and, reversely, the properties of the object can be determined from ϵ .

The observation frequencies and assumed fields of utilization of MSR are as indicated in Table 7. The absorption line of steam is represented by 22.235 GHz and, in the vicinities of 20.3 and 23.8 GHz, the weight function of steam for altitude has much the same value and the presumed accuracy is highest. Further, since clouds are composed of small waterdrops and their absorption coefficient is in general proportion to the square of the frequency, the effect of clouds can be eliminated from luminance temperature by using two frequencies and, moreover, the amount of cloud drop can be estimated.

Table 7. Areas of Utilization of MSR

Wavelength domain	Sensitivity characteristics	Assumed area of utilization
23.8 GHz	Steam, waterdrops, snow cover, sea wind reaction zone (vicinity of steam absorption line 22.235 GHz)	Steam amount, front observation (cold front, warm front) Rain area measurement Snow cover measurement
31.4 GHz	Ice, waterdrops, oil film, snow cover reaction zone	Ice measurement, measurement of cloud water amount, measurement of oil pollution, snow cover measurement

It is also possible to determine snow cover, sea ice and oil pollution distribution, etc., taking advantage of the difference in emissivity.

(4) DCS Data

As stated in 2 (1), DCST is a through repeater just to handle phase modulation by converting a frequency. So, DCP formula (such as random access, modulation formula, etc.) can be freely decided; thus, users can make various tests. DCP standard specifications and burst signal format are as shown in Table 8.

Table 8. DCP Standard Specifications and Intraburst Transmission Format

Item	Numerical values, etc.	
Transmitting frequency	401.5 MHz	
Effective radiation power	35 dBm	
Polarization	Right-circle polarization	
Modulation formula	PCM (Biφ-L)-PSK ($\pm 60^\circ$)	
Transmission formula	400 bps	
Emission formula	Burst emission of about a second for every 60 seconds	
Frequency stability	Case where position calculation is necessary	Case where position calculation is not necessary
Short term:	Less than 1×10^{-9} / 100 ms	Less than 1×10^{-8} / 100 ms
Intermediate term:	Less than 1×10^{-8} / 20 min	Less than 1×10^{-7} / 20 min
Long term:	Less than 1×10^{-6} / 1 hour	Less than 1×10^{-6} / 1 hour
Defense against continuous transmission	Use either of the following: 1) Detect within following range and stop transmitting for good: $1 \text{ sec} < T < 5 \text{ sec}$ 2) Detect within following range and stop transmitting temporarily for at least 15 minutes: $1 \text{ sec} < T < 1.1 \text{ sec}$	

Nonmodulation carrier	Modulation carrier					
	Bit synchronization	Frame synchronization	Start information	Number of sensor groups	DCP identifying information	Sensor data
160 ms (TBD)	15 bits	8 bits	1 bit	4 bits	20 bits	Nx32 bits (1 ≤ N ≤ 8)

5. Postscript

Oceanographic observation by the artificial satellite is the only way to elucidate phenomena of oceanic scale, such as general circulation and oceanic tide and is also useful for the elucidation of the space distribution of medium-scale disturbances, interactive exchange between the sea and

the air and the related variations. Furthermore, it provides us with wave information necessary for the safe and economical navigation of ships, surface water temperature distribution useful in prospecting for fishing grounds and other practical data. Marine Observation Satellite No 1 (MOS-1) purported to establish the basic techniques of this observation is a step toward realizing it and the MOS-1 project must be verified and evaluated so that its results may be reflected on the marine observation satellite to follow it. It is hoped that more and more people will be interested in MOS-1 data and use them.

20,108/9365

CSO: 4106/5038

AEROSPACE SCIENCES

OVERVIEW OF PLANNED TESTS OF SPACE MATERIALS

Tokyo TOSHI KEIZAI in Japanese Jan 86 pp 52-53

[Text] Advanced Technologies To Originate in Space in 21st Century

It is said that the advanced technologies in the 21st century will originate in space. Space is a world of weightlessness, nearly perfect vacuum, extremely high and low temperatures, abundant cosmic rays, and infinite solar energy. By utilizing the space environment with such extreme conditions it will become possible to manufacture with ease alloys, compound materials, electronic materials, medicines, and so forth, that are difficult to manufacture on the earth. In addition, it will become possible to carry out research on growing seeds, culture of microorganisms, life science, and others in space.

Expectations for these space experiments is so high that, in conjunction with the anticipation that space factories will be realized in the 21st century, the United States, Soviet Union, and European countries have been dealing actively with the space experiments, with some results already being obtained.

In the latter half of 1960's, materials tests in the space were attempted by using rockets. Subsequently, there was the Skylab project of the United States, the orbital science station "Salyut" series of Soviet Union, and others. However, what is attracting the highest expectation are the space experiments on the space shuttle of the United States. It is to carry out various kinds of experiments in the Spacelab that was developed by European Space Agency (ESA) and placed on board the space shuttle.

Success in Refining of Hormones

Since the first flight in April 1981 the space shuttle has made round trips to and from the space and the earth for a total of 22 times. In the field of space materials tests, it succeeded in the refining of highly pure medicinal hormones by the use of an apparatus (EOS) for separating and refining living cells in the space by the electrophoresis method, developed by McDonnell-Douglas Co. in the United States.

In addition, 3M Co. succeeded in depositing crystals from organic solution in the DMOS (diffused mixing of organic solutions) test under the cooperation of

NASA of the United States, obtaining a large number of beautiful white and transparent crystals of urea. Furthermore, in the third Spacelab experiment this fall, a West German team succeeded in forming compound semiconductor crystals from mercury and iodine. As the above events indicate, space experiments by the use of space shuttle are piling up results steadily.

Japan Will Join Space Tests on Full Scale in 1988

Japan is not simply standing by helplessly. The space tests have to proceed by mutually overlapping the basic ground tests, rocket tests, and tests on the orbit. In Japan, with the Science and Technology Agency as the center, ground tests and rocket tests are being carried out in cooperation with National Space Development Agency, Metallic Materials Research Laboratory, Institute of Physical and Chemical Research, and others.

The National Space Development Agency started in 1980 the space materials tests by using two-stage small rocket TT III 500 A. With a small electric oven that is placed on board the rocket, they succeeded in the manufacture of compound alloy of nickel, titanium, and carbide, amorphous semiconductor of silicon, arsenic, and tellurium series, and single crystal compound semiconductors. They confirmed that these possess properties superior to materials that are obtained on the ground.

As the next step, full scale space tests that make use of the Spacelab are scheduled to take place in early 1988.

Namely, by renting about half the space in Spacelab, National Space Development Agency is planning to carry out a total of 34 tests including manufacture of electronics materials and high-purity glasses, and separation, refining, and culture of pure living samples that are expected to be applicable to the manufacture of new medicines and the like.

This project is called the first round materials tests (FMPT), and the three astronauts (actually only one of them will fly) who are to ride on the shuttle have already been selected. The actual cost for the tests is estimated at about Y20 billion. The second and the third rounds of tests that will follow the first are now under planning and preparing for the construction of a space station in the 1990's.

In addition, MITI has concluded an agreement with the research workers of West Germany to co-ride on their space laboratory project (D series), in order to promote the industrial utilization of space. It is expected that the test will be carried out by a company that will be owned commonly by the makers in the fields of semiconductors, biotechnology, and new materials. About 20 companies including NEC Corp., Hitachi, Ltd., Fujitsu, Ltd., and Ishikawajima-Harima Heavy Industries Co., Ltd., have indicated their interests in founding of new company. According to the plans, three tests will be carried out between 1988 and 1991.

NEC Corp. tried their fourth new materials manufacture test during the shuttle flight in April of last year. These tests are the following three, namely, experiment for mixing diamond particles with glass particles, semiconductor

recrystallization experiment of indium and antimony, and fusion experiment of zinc and lead that cannot be realized on the ground. The results of these tests were not revealed due partly to the involvement of proprietary information.

In addition, Fujitsu, Ltd. is planning to carry out a growing test of large compound semiconductor crystals such as gallium arsenide by making use of the get-away-special (GAS) which is a small experimental apparatus on the shuttle, in the next spring if it can be done.

Moreover, Mitsubishi Corp. obtained the right to act as agency for use of the EOS device that was developed by McDonnell-Douglas Co. Hayashibara Biochemical Laboratory, as the first to contract for the use of the device, is to challenge the extraction test of (physiologically active) substances next June.

The test is thought to be aimed at extracting anticancer substances or the like, a procedure that is difficult to carry out on the ground. This is because the separation and refining functions of the EOS are enhanced sharply under the weightless condition. Regarding the utilization of the EOS, the Green Cross Corp., Mitsubishi Chemical Industries, Ltd., Kyowa Hakko Kogyo Co., Ltd., and others are said to be enthusiastic.

In addition, the Association of Japanese Aeronautical and Space Industries has decided to carry out 12 experiments including those on gallium arsenide single crystal, optical crystals, and ferromagnetic materials, by the use of the GAS shuttle device starting the next spring. Therefore, space materials tests in Japan will begin full scale activities starting next year [1986].

20,121/9599
CSO: 4306/2542

AEROSPACE SCIENCES

BRIEFS

SPACE GROUP LAUNCHES SATELLITE--Tokyo, 7 May KYODO--Japan's Space Communications Corp said Wednesday it has signed a contract with Arianespace of Europe to launch two communications satellites in 1988. Space communications, set up last year by Mitsubishi Corp and Mitsubishi Electric Corp, cancelled plans to launch the satellites aboard American rockets due to a delay in the U.S. shuttle program following the explosion of a challenger rocket in January, company officials said. The officials said the two satellites, 1.3-ton "super birds," are scheduled for launch in February and November 1988 from a space center in French-held Guiana. Arianespace is a consortium of European companies that operates the Ariane rocket launching program for space satellites. The value of the contract was not revealed. [Text] [Tokyo KYODO in English 0252 GMT 7 May 86 OW]

/12929

CSO: 4307/010

BIOTECHNOLOGY

NEW ANTICANCER DRUG, KAZUSAMYCIN, DEVELOPED

Tokyo BIO INDUSTRY in Japanese Mar 86 pp 22-28

[Article by Iwao Umezawa, Chief, Research Division, Kitasato Research Institute]

[Text] Anticancer drug screening should be based on a broad but focused concept. When an application takes advantage of a special feature of the substance obtained, even greater efficacy is likely to be attained. Preceding the clinical application of the newly developed anticancer antibiotic, Kazusamycin, basic studies are underway such as mode of action, side effects, and combined use with monoclonal antibodies, etc.

1. Introduction

The role of chemotherapy in cancer treatment is by no means insignificant, and everyone recognizes the fact that it has played a big role as a supplementary treatment to surgery and radiation therapy, at times performing the major role. However, with some exceptions, it has not been fully satisfactory against solid tumors, and the development of anticancer drugs with even greater efficacy is awaited.

There are two types of anticancer drugs, those originating from natural substances and artificial products made by synthesis. From the aspect of mode of action, they can be divided into two groups: substances that inhibit the growth of the tumor cells by acting directly on tumor cells to cause damage; and substances that regulate or modify their intrinsic biological resistance (Biological Response Modifiers: B.R.M.).

As for screening methods, irrespective of the in vitro or in vivo method, several paths have been available in the past such as using protozoa or plants, or cancer cells as indicators. Ultimately, however, a method using cancer cells, frequently animal tumors, has been the choice. The reason is that in the clinical use of a new substance, there is absolutely no case where clinical use results from in vitro experimental data or active efficacy against other than tumor cells; the application to human cancer is always

attempted based on therapeutic results against animal tumors.

Consequently, we arrive at the question of what kind of mammalian tumors are directly linked to results with human cancer therapy. Sometime ago, L-1210 leukemia cells were adopted as the target tumor at a conference of the U.S.-Japan Joint Committee for screening new anticancer drugs. Although tests have subsequently been performed on cells ranging from Lewis lung carcinoma and B-16 melanoma to colon 26 and 38, no decisive tumor has been discovered as yet. Thus, at present, each worker determines which tumor to use for screening based on his own judgment.

Over the past 30 years, our group has also been studying the problem using various tumors but we have not yet arrived at a point of definitive assurance and are using various tumors from diverse angles, being unable still to depart from the stage of groping in the dark. However, this is not to say that all were in vein, but, we have established a suitable method for our purpose of developing a certain type of anticancer drugs that have a common mode of action such as metabolic antagonists in the broad sense. However, we have not yet reached the point of discovering the most desired common characteristics between human cancer and animal tumors with respect to efficacy.

We have consistently used animal tumors for screening and discovered several kinds of anticancer antibiotics since mitomycin¹⁾, including iyomycin²⁾, kidamycin³⁾, sporamycin⁴⁾, stubomycin⁵⁾, awamycin⁶⁾, etc. In addition, we have recently reported on a new type of anticancer antibiotic, kazusamycin^{7),8)} and trienomycin¹⁰⁾, parts of which are introduced here.

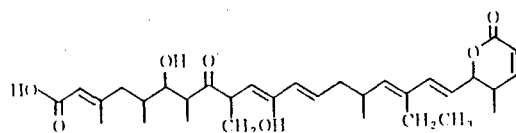
As stated previously, substances called anticancer drugs can be divided into two categories: chemotherapeutics and BRM from their mode of action. We have been conducting our search mainly for substances having direct action. As is well-known, numerous anticancer drugs have been reported, and although they are known to show efficacy against certain specific cancers, therapeutic results are not yet sufficiently satisfactory for cancers of stomach, lungs, and intestines, which are the center of discussion here. I think there are various reasons for this, but one of the causes is the poor delivery of the drug to tumor sites. In other words, it is due to poor selective toxicity of the anticancer drugs. Therefore, we tried screening substances with high selective toxicity on various tumor cells, but many substances still have strong side effects.

Going along the basic line to look for substances with cytocidal action against animal tumors, we tried to screen low molecular weight, strongly cytotoxic substances.

As a result, we discovered that a substance that suppress the growth of HeLa cells at extremely low concentration is produced in the culture filtrate of an actinomycete. When an attempt was made to extract and purify an effective substance, we were able to obtain white needle-form crystals and called it

Kazusamycin.

The structure of Kazusamycin is as follows:



Kazusamycin

Its physicochemical properties are shown in Table 1.

Kazusamycin is a substance in which an unsaturated fatty acid is bonded to an s-lactam ring. Although it does not act on ordinary gram-positive and -negative bacteria, it exhibits a minimum inhibitory concentration (MIC) of 0.1 microgram/milliliter against some yeast *Shizosaccharomyces* and 2.5 microgram/milliliter against *Phizopus javanicus* (Table 2).

Table 1
表1 Physicochemical properties of Kazusamycin

Molecular formula	C ₃₃ H ₄₈ O ₇
Molecular weight (FD MS)	556
[α] _D ²⁰ (c=0.1, methanol)	-83.5°C
UV absorption in MeOH (ϵ)	λ_{max} 232nm (33000) (shoulder) 245nm (30400)
IR ν_{max} (KBr, cm ⁻¹)	3450, 2980, 2950, 2900, 1705, 1640, 1458, 1380, 1285, 1258, 1160, 1100, 1043, 965, 820
Rf value (Kieselgel 60 F ₂₅₄)	0.33 (ethyl acetate: methanol=40:1) 0.28 (chloroform: methanol=10:1)

Table 2
表2 Antimicrobial spectrum of Kazusamycin

Test organism	MIC (μ g/ml)
<i>Staphylococcus aureus</i> FDA 209 P	> 100
<i>Bacillus subtilis</i> PCI 219	> 100
<i>Micrococcus luteus</i> ATCC 9341	> 100
<i>Escherichia coli</i> NIHJ	> 100
<i>Shigella sonnei</i> E-33	> 100
<i>Trichophyton rubrum</i>	> 100
<i>Candida albicans</i>	> 100
<i>Saccharomyces sake</i>	> 100
<i>Aspergillus niger</i> ATCC 6275	> 100
<i>Schizosaccharomyces pombe</i> IAM 4863	0.1
<i>Phizopus javanicus</i> IAM 6241	2.5

2. Biological activity of kazusamycin

2.1 Cytocidal action against HeLa cells

As shown in Fig. 1, kazusamycin was added in various concentrations to HeLa cells cultured for 48 hours and the trend of cell growth was studied. At 24 hours after drug addition, it showed about the same trend as the control group; at 72 hours after addition, cell growth was inhibited at the very low concentration of 0.98 nanogram/milliliter.

Furthermore, when HeLa cells were exposed to the drug for 3 hours and the effect on their growth was examined, a mere 23 percent inhibition was found when 214 nanogram/milliliter was used, which is believed to be a relatively large quantity for in vitro use. When these data are considered along with

the previous experiment, although this substance is believed to have cytotoxic effect at a low concentration, it is a drug that has a time-dependent action. Therefore, we then studied the *in vivo* antitumor effect.

2.2 Efficacy against experimental tumors

Therapeutic effects were examined using several kinds of experimental tumors that are preserved in various passages in the laboratory.

2.2.1 Effect on ascites tumor

Ehrlich ascites tumor and sarcoma 180 ascites tumor were transplanted into the abdominal cavities of ddY mice and treated using three different regimens: single dose, three divided doses, and 5-day consecutive use beginning 24 hours following inoculation. Although life extension was increased only 1.5- to 2-fold for both tumor groups, there were some cases where complete healing occurred in one or two out of five mice.

Next, therapeutic effects were examined using the same dosages on homogeneous tumors, IMC carcinoma. As shown in Table 3, results superior to those on Ehrlich or sarcoma 180 were obtained. In other words, very interesting results were obtained in some cases showing a life extension of more than three-fold. Moreover, some therapy groups showed up to 60 percent healing rate. However, only a minimal life extension effect was shown against the leukemia cell P-388.

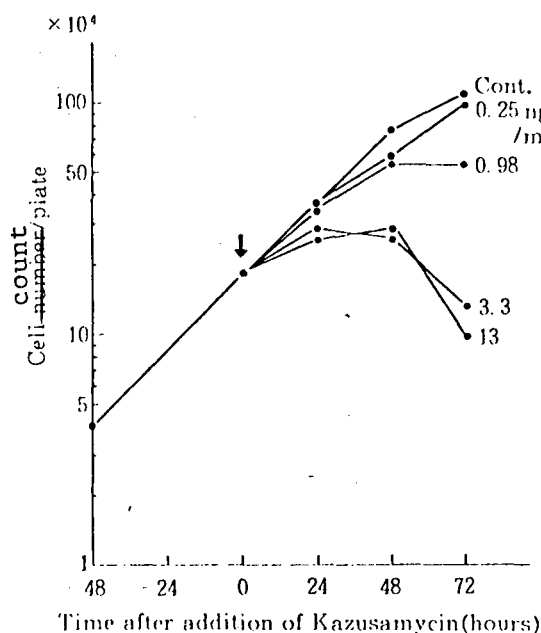


図1 Cytocidal activity of Kazusamycin
Fig. 1 on HeLa cells

Table 3
表3 Effect of Kazusamycin on IMC
carcinoma

Treatment schedule	Total dose (mg/kg)	MSD	Range	ILS(%)
Saline		14.6	13-16	0
	0.63	11	3-22	25
	0.31	30.8	18-52	111
Day 1	0.16	40.7	20-54	179 (2)
	0.08	47.8	43-50	227 (1)
	0.04	28.5	19-42	95 (1)
	0.02	30.7	18-54	110 (2)
	1.25	27.0	19-53	85 (1)
	0.63	43.6	24-52	199
Days 1, 5, 9	0.31	25.3	19-38	73 (2)
	0.16	32.8	18-50	125 (1)
	0.08	30.0	17-43	105 (3)
	0.16	19.8	6-29	36
	0.08	42.0	27-60	188 (1)
Days 1-5	0.04	45.6	39-49	212
	0.02	53.0	48-58	263 (3)
	0.01	29.8	20-50	104

IMC carcinoma cells (1×10^6) were inoculated ip into CDF₁ mouse (female, 6 weeks old), and mice were given ip injections of the antibiotic.

2.2.2 Effects on solid tumors

A transplant of 1×10^6 IMC carcinoma cells, against which drug efficacy was found in the ascites form, was made in CDF₁ mouse hypodermis and daily treatment by intraperitoneal administration began 24 hours later for 5 consecutive days. The results shown in Table 4 were obtained. The therapeutic effect of kazusamycin was determined by the tumor size on the 42nd day after inoculation. Compared with the control group, less tumor growth occurred in therapy group; an efficacy of 43-63 percent growth suppression was found including a group in which complete disappearance of tumors occurred in two cases.

As shown above, the therapeutic effects against the homogeneous tumor, IMC carcinoma, was superior to the effects on heterogenous Ehrlich and sarcoma 180 ascites tumors. Furthermore, the efficacy found against subcutaneous tumors is a very interesting result.

However, when compared with in vitro efficacy, the in vivo results were not as marked as expected. This is believed to be partly due to the fact that the drug is inactivated by enzymes, etc. by internal use or poor delivery to the tumor sites.

Therefore, in order to increase delivery, first the effect on lymph nodes having high metastatic probability was examined. In other words, kazusamycin was prepared in liposomes of lecithin cholesterol and phosphatidic acid. In order to study whether or not liposome-coated kazusamycin has a cytotoxic action, kazusamycin-liposomes were dissolved in physiological saline, diluted to the concentrations shown in Table 5, and allowed to act on HeLa Cells. A cytotoxic action was demonstrated even at a concentration of 0.6 nanogram/milliliter. In other words, it was found that a kazusamycin-containing liposome, although in vitro, releases kazusamycin from the liposome following cell contact and directly act on the cell.

Table 4
表4 Effect of Kazusamycin on IMC solid tumor

Total dose (mg/kg)	Mean tumor Day 29	Size (mm ²) 42	61-day Survivors
Saline	312	1193	0/5
0.16	169 (46)	658 (45)	2/5*
0.08	181 (42)	675 (43)	2/5*
0.04	120 (62)	439 (63)	2/5
0.02	215 (31)	618 (48)	0/5

IMC carcinoma (1×10^6) was inoculated subcutaneously into CDF₁ mouse (female, 6 weeks old), and mice were given ip injectors of the antibiotic on days 1-5.

Numbers in parenthesis indicate percent of growth inhibition. Control mice died between days 49-54.

* Without solid tumor.

Table 5
表5 Cytotoxicity of Kazusamycin liposome(unilamella) on HeLa cells in vitro

sample	conc.(ng/ml)	cytotoxicity
Liposome suspension	5.3	+++
in saline	1.7	+++
	0.6	++
	0.2	
Liposome bound	5.3	+++
monoclonal antibody	1.7	+++
in saline	0.6	-
	0.2	-

HeLa cells were exposed to the samples for 72 hr, and were fixed with methanol, stained with Giemsa solution.

+++ All cells died
++ A remarkable change
+ A slight change
- No change

Next, an attempt was made to bind kazusamycin to monoclonal antibodies produced by spleen cells, which were obtained from mice immunized with human-heteroprotein.

The above-mentioned monoclonal antibodies and liposomes were bound with a disulfide bond cross-linking agent using Leserman's method¹¹⁾. This product was allowed to act on HeLa cells using the same method as in the case of liposomes. The growth of HeLa cells was suppressed at a concentration of 0.6 nanogram/milliliter as shown in Table 5. In other words, it was confirmed that the cytotoxic activity of kazusamycin, either encapsulated in liposomes or further bound to antibodies, is scarcely diminished. Therefore, Kazusamycin suitably bound to monoclonal antibody was prepared and its antitumor property is being examined in vivo.

3. On side effects

Many of the anticancer drugs that have been reported have strong side effects, especially against bone marrow cells. Frequently, they act on hematopoietic organs before tumor cells completely disappear, inducing a reduction in white blood cells and platelets, etc. resulting in the inevitable discontinuation of drug use.

Therefore, in order to examine the effects of kazusamycin on the bone marrow, 0.63, 1.25 or 2.5 mg/kg kazusamycin was administered into the caudal veins of mice and the white blood cell count in the peripheral blood was examined three days and six days later. Although a slight transient decrease was found on the third day, a recovery trend was shown on the 6th day. As stated,

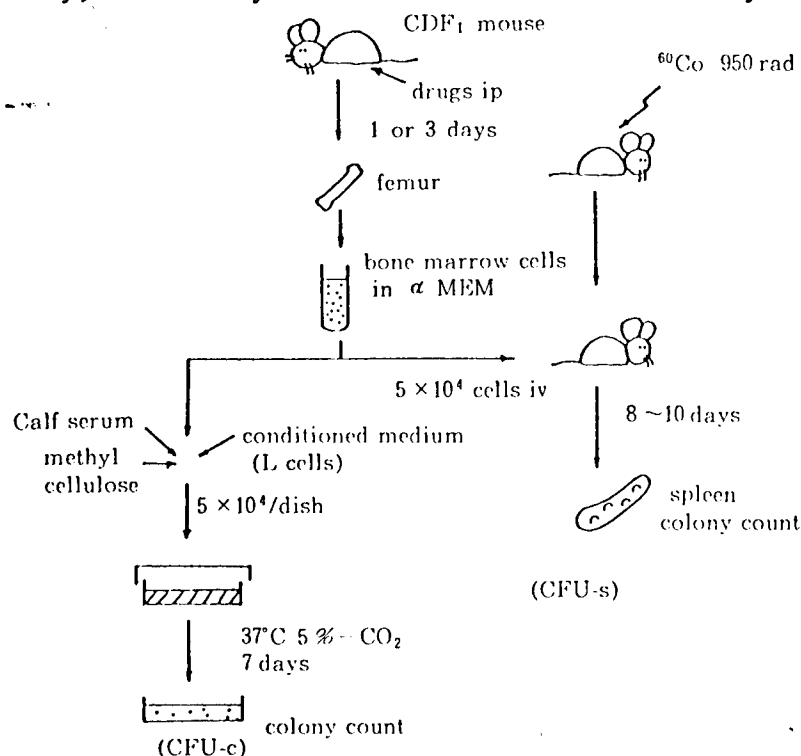


Fig. 2

図2 Methods of bone marrow hematopoietic stem cells(CFU-s) and colony-forming unit in culture(CFU-c) assay

despite the fact that kazusamycin has a strong cytotoxic action, it does not affect the peripheral white blood cell count. Therefore, the direct effect on bone marrow was studied by further examining colony forming units. This method is shown by a diagram (Fig. 2).

3.1 Colony forming units in the spleen (CFU-s)

Following intravenous administration of 1.25 and 2.5 mg/kg kazusamycin to donor mice, the animals were killed on day 1 and day 3, bone marrow cells were removed from the femur, suspended in alpha-MEM medium, and the cell count was adjusted to a constant. A 0.1 milliliter portion of this bone marrow cell suspension ($5 \times 10^5/\text{ml}$) was inoculated into the caudal vein of each recipient mouse, previously exposed to total body irradiation with 950 R of Cobalt 60 (lethal dose). The mice were killed on the 10th day and the spleens were excised and fixed in Bouin's solution. The number of colonies formed on the spleen surface was determined.

As a result, the colony forming rate of ACNU used as a positive control was considerably lower, whereas groups administered 2.5 mg/kg and 1.25 mg/kg kazusamycin showed no significant difference from the control group in colony counts at days 1 and 3 (Fig. 3).

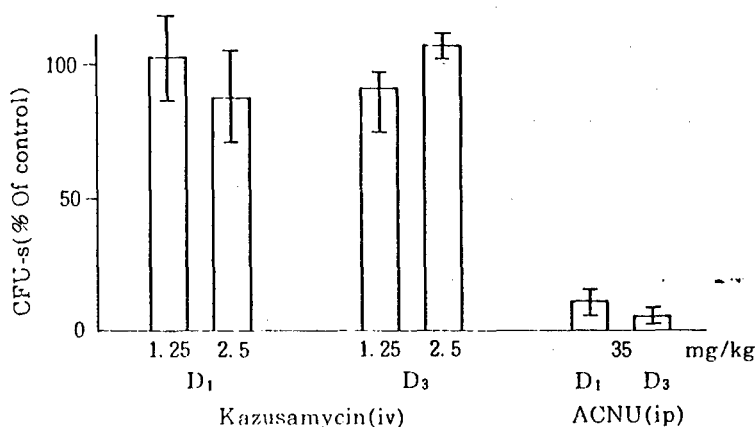


Fig. 3 図3 Effect of Kazusamycin on bone marrow CFU-s

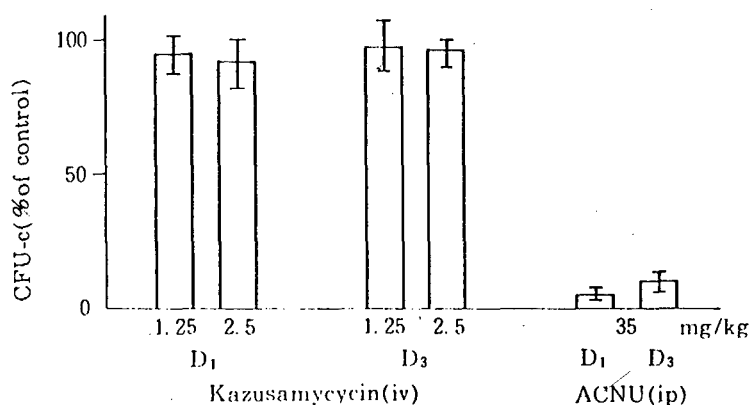


Fig. 4 図4 Effect of Kazusamycin on bone marrow CFU-c

3.2 Colony forming units in culture

The bone marrow cells sampled in the same manner as in CFU-s were suspended in alpha-MEM medium containing FCSL cell culture filtrate and methylcellulose, etc. They were streaked on a petri dish (1×10^5 /plate), cultured for 7 days at 37°C, and the colony count determined. As a result, as shown in Fig. 4, the number of bone marrow cell colonies formed from the mice administered ACNU used as a positive control decreased markedly, whereas the kazusamycin-administered groups showed no significant decrease compared to the control group on either the first and the third day.

As shown above, kazusamycin is believed to have little effect on peripheral white blood cells as occurs with other anticancer drugs such as ACNU, or CFU-c and CFU-s results showed no effect on the bone marrow cells, either.

4. Conclusion

The targets of cancer chemotherapy tend to be restricted mainly to cancers of the blood such as leukemia. However, their efficacy against solid tumors has recently been observed, and it is certain that the achievement is showing a steady growth.

On the other hand, it is a fact that we are still groping in the dark in many respects, and the development of new types of anticancer drugs is desirable. One of the reasons is a lack of knowledge concerning the differences between animals and man; efficacy shown against animal tumors does not necessarily prove applicability to human cancers, which is evidenced only by use in humans. On the other hand, from the standpoint of drugs, the reason is the difficulty in designing drugs. As long as the structure of the substance effective against human cancers is unknown, it is necessary first to screen at random and develop effective substances having new structures, and derive superior substances by variously modifying those structures.

In the future development of new drugs, it is important to know the "biology of cancer," and at the same time, the anticancer approach should be considered from broad points of view.

Anticancer drugs are not only incapable of destroying tumors completely, but cancer chemotherapy is burdened with many fundamental problems such as drug sensitivity and resistance, antimetastasis effects, delivery to the tumors, inactivation, etc. Unless these problems are solved one by one, there is no path open to defeating cancer. In developing anticancer drugs in the future, I think it is important to focus on a target and not get caught in a fixed ideology, confront with everything with open mind, and to discover the usage that takes full advantages of the properties of the substances obtained.

FOOTNOTES

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DEFENSE INDUSTRY

ASPECTS OF NEW DEFENSE PROGRAM QUESTIONED

Tokyo GUNJI KENKYU in Japanese Nov 85 pp 24-38

[Article: "Is the New Defense Program Infallible?"]

[Text] Is the new defense program, which has been upgraded to a government program, really substantial? Is there a problem in pursuing the purchase of new equipment for the air and naval defense forces at the expense of preparation of ground forces?

Introduction

As reported already, a "Mid-Term Defense Buildup Program" was announced on 18 September [1985]. It is a version of the past "Mid-Term Operations Estimates" upgraded to a government-level decision. The Manchurian Incident began 49 years ago that day, launching Japan on a new path. The use, coincidentally perhaps, of that anniversary to announce a new defense program strikes one with a certain emotion. The estimated budget requests for fiscal 1986, important as the first year of this program, were already announced in late August. Then came the announcement of the defense program itself. Indeed, this should have been the opposite. How unprincipled, how unscrupulous!

As expected, the announcement said that the framework of the "Essentials of Defense Planning" laid down in 1976 remained intact and that a level of defense capabilities would be achieved in accordance with this framework. A framework that does not change in spite of the great change of international situations could not convince one, but the "Essentials" are worded cautiously. Its text is so abstract and ideologically that it permits any interpretation. The "Essentials Appended Table" is represented in terms, mainly, of the number of organizational units and includes no specific mention of their quality and capabilities. For example, the shore-based antisubmarine air unit of the Maritime Self-Defense Force is the only organizational unit shown in the appended table that had not been realized by fiscal 1985. (Fourteen of the 16 units had been organized by fiscal 1985.) So, anything short of nuclear armament could be achieved if the number of organizational units and the number of naval vessels or aircraft are not altered.

Seen as a whole, the program is conspicuous for its "emphasis on the navy and the air force" which is receiving much fanfare. That is all right, but the question is whether it is the result of some definite strategy. It shows how the navy and the air force take advantage of "emphasis on the navy and the air force" to grab budget appropriations, leaving the army managing with what little it can get. A happy Air Self-Defense Force, an equally happy Maritime Self-Defense Force and a sulky Ground Self-Defense Force-- this situation should not be allowed to happen.

Anyway, this "Mid-Term Defense Building Program" has four emphases:

1) improvement of homeland air defense capabilities, 2) improvement of the ability to assure safety in marine transportation, 3) improvement of the ability to cope with invasion from air and sea, 4) balance between the front and the rear and 5) utmost efficiency and rationalization while striving to apportion natural resources with priority and further organized cooperation among the three Self-Defense Forces and produce the effect of their concerted operation.

The cost of this program is estimated at about ¥18.4 trillion assuming the average real growth rate to be 5.4 percent, the amount of new contracts for front equipment is estimated at about ¥5.55 trillion by the price basis of fiscal 1985 and the amount to be borne annually in fiscal 1990 and subsequently is estimated at about ¥2.55 trillion. Now, the much-talked-about ratio to GNP is estimated at an average 1.04 percent, using a GNP real growth rate of 4 percent. Thus, the once-controversial breakthrough of the 1 percent barrier will materialize quite easily.

What a performance! How smart! But it seems the matter should have been discussed more thoroughly. All the more so because it was a good opportunity to accustom the general public to the issue of defense.

Improvement of Homeland Air Defense Capabilities

The improvement of homeland air defense capabilities tops all high priorities. This is probably because the program basically takes advantage of the Japanese geography as a sea-girdled nation and is based on the idea that the chances of invasion from air or sea are small as long as air superiority in the skies above the homeland and its coasts is secured. This idea is justifiable from war history. But history also shows that any invader first strikes to destroy the enemy's air force. As a countermeasure against this, there is emphasis 4), improved invulnerability by the balance between the front and the rear. Here, we shall see about the buildup and modernization of fighter interceptors and surface to air guided missiles.

Buildup of F15 Fighters

Upon completion in fiscal 1985, the main fighter interceptor force will comprise five F15 units (115 planes) and five F4EJ units (130 planes). By the time of completion of the program, the proportion of F15's will be increased to seven F15 units (163 planes), compared with three F4J units.

Type	Number to be procured in FY 1985	Upon completion in FY 1985	Amount to be procured under new program	Upon completion of new program
Ground Self-Defense Forces	Tanks (including new type)	1,146	246	1,205
	Artillery pieces	2,161	277	2,207
	Armored cars	639	310	949
	Surface to ship guided missiles	0	54	54
	Antitank helicopters (AH1S)	32	43	74
	Transport helicopters (CH47)	5	24	29
	Equipment for improving Hawk surface to air guided missiles	(1 improved group)	Improved 2 type: 4.5 groups	Improved 1 type: 4 groups Improved 2 type: 4.5 groups
	Escort vessels (ME)	3	9	62
	Submarines	1	5	16
	Others	2	21	93
Maritime Self-Defense Forces	Total of naval vessels (Tonnage)	13,000	69,000	171
	Operational aircraft	20	128	327,000
	Included: Fixed wing antisubmarine patrol planes (P3C)	10	50	214
	Antisubmarine (including new antisubmarine helicopters (ship-carried type))	10	66	94
	Minesweeping helicopters (MH53E)	0	12	102
	Others	0	0	12
	Operational aircraft	17	87	6
	Included: Fighter interceptors (F15)	14	63	415
	Transport planes (C130H)	2	7	163
	Transport helicopters (CH47)	1	12	14
Air Self-Defense Forces	Early warning planes (E2C)	0	5	14
	Others	0	0	12
	Medium training planes (T4)	0	93	212
	Surface to air guided missiles (Patriot)	0.5 group	0.5 group	5 groups
				5.5 groups

F15's which cost as much as ¥10 billion apiece are possessed only by the United States, war-prepared Israel, overly dollar-rich Saudi Arabia, and Japan with the second largest GNP in the world. By the end of fiscal 1985, Japan will rank second in the number of F15's possessed and the program proposes to increase their number further. When the program is completed, F15's and Patriot SAM's together will make Japan's air defense capabilities third largest in the world--at least in quality.

But to this end, it is necessary not only to make military bases invulnerable and modernize the warning setup but also to achieve more efficient links with the U.S. Air Force. Not all the objects of the hundreds of air scrambles that are made are Soviet planes. The radar sites are very busy during the annual Team Spirit exercises, hence, the necessity of an allied command structure like NORAD. Even if the general headquarters includes USAF liaison officers, it is absolutely necessary to form command control relations at a higher level.

Reinforcement of E2C's

Japan will have eight E2C warning planes, which play the main role in coping with very-low-altitude invading planes, by the end of fiscal 1985; five will be added under the new program. Thus, a 12-plane setup (including one in reserve) will materialize, bringing the number of warning patrol points up to three from two. Considering the links with the MSDF's P3C antisubmarine patrol planes and the Maritime Safety Agency, this is the best way to spend tax revenues.

Improvement of F4EJ Capacities

There will be more than necessary F4EJ's as the result of the introduction of F15's. But F4EJ's are good planes that can be used in the future. So, 17 of them will be remodeled into reconnaissance planes while those with which three units will be equipped will be the type with improved capacities.

The point in remodeling F4EJ's consists of replacing their radar type with APG66 carried by the F16 and adding the same central computer and headup display that are carried by the F15 as well as INS (inertial navigation system) for the A10 attack plane. Thus, F4EJ will have improved look-down and other capacities, be able to carry ASM1 air to ship missiles and nearly equal the F15 in the capacity to attack the ground. Its air defense capacity will also increase because of the ability to carry AIM7F and AIM9L.

Use of Patriot SAM as Main Weapon

The surface to air guided missile force at the time of completion in fiscal 1985 will comprise six Nike groups and 0.5 Patriot group. But at the time of completion of the new program, it will comprise a Nike group and 5.5 Patriot groups. One group is composed of four FU's (fire units: one FU having five quadruple-mount launchers). One FU is said to cost about ¥20 billion. Because of this high price, only four countries, the United States, West Germany, the Netherlands, and Japan have decided to procure the Patriot by now.

Once there was talk of the GSDF Hawk force switching to the Patriot but they gave this up. The Hawk force at the time of completion in fiscal 1985 will comprise four early-type groups and 4.5 improved 1-type groups, but at the time of completion of the new program, it will comprise four improved 1-type groups and 4.5 improved 2-type groups. Since the improved Hawk has a maximum range of only 40 kilometers (compared with the Patriot's effective range of 70 kilometers) and cannot either cover from very low to very high altitudes, as does the Patriot, or cope simultaneously with a plural number, which the Patriot can, it seems likely to be shifted from duties including key-area air defense, as in the past, to exclusive use in combat-zone defense.

Improvement of Ability To Assure Safety in Marine Transportation

As stated in the preceding chapter, this program is aimed, primarily, to make the most of the advantages of a country as a sea-girdled nation. But this has its disadvantages, too, and means that if the SLOC (see lane of communication) is threatened, instead, the country will be doomed before it fights. That is precisely what happened to Japan in the last part of the Pacific War. Under these circumstances, the program requires the ability to defend the surrounding seas and the ability to assure safety in sea traffic as the second most important matter.

Encouraged, perhaps, by the Japanese tradition as a sea nation, the Maritime Self Defense Force worked quite adroitly to build up its war potential. Though the MSDF men recall with self-scorn how they started as "gutter cleaners," their present minesweeping force made up of 38 ships is at the world's top in both quality and quantity. The Japanese navy including the vessels of the Maritime Safety Agency which will be placed under the MSDF's command in case of an emergency has been so developed that it surpasses the British Navy.

Yet, building naval craft takes money and time. Besides, the lives of naval craft operating on the front are unexpectedly short. For these reasons, the goal of having about 60 escort vessels as envisaged by the "Essentials" was not easily accomplished. Particularly, the Amatsukaze was the one costly DDG (guided missile destroyer) that Japan had during the decade beginning 1965. This fact indicates the problems that beset the Maritime Self Defense Force.

System of 62 Escort Vessels

Upon completion in fiscal 1985, there will be 58 escort vessels, thus giving the impression that accomplishment of the goal set by the essentials is near at hand. But these include some that are more than 20 years old. Further, the number of DDG's now available is inadequate to place the four escort flotillas being maneuver-operated as the nucleus of the MSDF fleet on the eight-ship, eight-plane basis (1 DDH, 2 DDG's, 5 DD's and 8 antisubmarine helicopters).

So, the program proposes to construct two DDG's, one DD and, for the regional units, six DE's and thereby realize a system of 62 escort vessels. The DDG's to be constructed are the 4,500-ton Hatakaze type and the total number of DDG's in possession will then be eight: namely, one 3,800-ton Amatsukaze type ship, three Tachikaze type ships and four Hatakaze type ships, and each escort flotilla will have two DDG's. The one DD to be constructed is a 3,400-ton enlarged Hatsuyuki type ships and the six DE's will be 1,400-ton Yubari type ships. The total number of DE's will then be 30 and six will be possessed by each of the five units that exist.

The Maritime Self Defense Force may want all these to be the Chukugo, Ishikari, and Yubari type DE's but the number of DE's of these types will be inadequate even after six are built under this program and there will be no choice but to use for the rest of the DE's the outdated DDA (escort ship with an improved antiaircraft capacity) and DDK (escort ship with an improved antisubmarine capacity) types.

As for submarines, five will be constructed in anticipation of the retirement of Asashio type ships and thus the goal of 16 submarines set by the essentials will finally be accomplished. All MSDF submarines will then be the teardrop type.

The Maritime Self Defense Force makes a point of first denoting its defense plan with definite figures and putting up a trial balloon in the easily understandable form of "eight ships, eight planes," for example, and then, if that is not enough, files a cool demand. How smart it is! Great, in a way, and sharp.

Increase of P3C's

At the time of completion in fiscal 1985, there will be 76 fixed wing anti-submarine patrol planes (49 P3C's and 27 P2J's); to bring this total to 100 (94 P3C's and 6 P2J's) as a long-cherished hope, 50 P3C's will be procured. As far as P3C's go, the Maritime Self Defense Force will then be the peer of the U.S. Navy. Perhaps, this many P3C's are necessary because a tracking relay like the Norway-Britain-U.S. relay across the Atlantic is difficult with Japan.

As minesweeping helicopters rendering quick sweeping possible, four V107's are now in MSDF possession and the program proposes reinforcement to 12 MH53E's. The MH53E is the latest of the type of which even the U.S. Navy now possesses only three and has eight on order. The Japanese choice leaves some doubt as to why so many are needed.

Improvement of the Ability To Cope With Invasion From Air and Sea

Regarding the question of what should be done if Japan is invaded, the program stresses destroying the invaders at sea and on the shores, presumably because of the fundamental policy with emphasis on the navy and the air force. After all, the point is what should be done to frustrate invasion rather than what should be done if the country is invaded. This, it seems, is too optimistic.

The program says that, to this end, long-range fire power, armor maneuverability and antitank fire power will be built up and modernized. But this is just one of the problems. Nothing can be fundamentally solved unless the general framework of 180,000 men for the Ground Self Defense Force is lifted. Anything that may be done without taking this step will not succeed. The sight of the Ground Self Defense Force managing at great pains to develop somehow in spite of this framework does not inspire awe so much as pity.

Introduction of SSM's

The SSM (surface to ship [as published] guided missile) is just about all the favor granted to the Ground Self Defense Force and the sole means by which it can participate in the scheme to destroy the enemy at sea. The program proposes to organize three new units with 54 SSM's (16 SSM's for each unit plus six for training use). (For information on SSM's, see the July 1981, issue of this magazine.) It is presumed that the three units will be disposed in Hokkaido, particularly its eastern and northern parts, so that their coverages may overlap each other.

This, apart from the sea monitoring radar, the fire control radar, the relay system, the control system and the Hawks, is an entirely new weapon system for the Ground Self Defense Force and requires training efforts, especially the securing of firing grounds. It will also require great effort to secure men for the new units from within the general ranks of GSDF which will remain unchanged. When organizing a new unit, men must be selected carefully: making shifts indefinitely would lead to an inevitable deadlock.

Regarding a successor to the F1 support fighter which attacks with the ASM1, protagonist in the scheme to destroy the enemy at sea, the program merely propounds "separate discussion" as to whether it should be a Japanese product, a convert from a currently possessed type (remodeled F4EJ) or a foreign plane to be newly procured.

Modernization of Equipment

The program proposes to prepare 246 tanks (216 74-type and 30 TKX's), 277 artillery pieces, 310 armored cars, 123 anticraft and antitank guided missiles (79-type heavy MAT's) and 43 AH1S antitank helicopters.

Thus, the number of tanks, cadre of the ground combat force, to be prepared under the new program is 100-odd smaller than the number to be procured under the 1981 Mid-Term Operations Estimates. This, along with division reorganization to be described later, will continue to dissatisfy the Ground Self Defense Force. In terms of figures, there will be 1,205 tanks as of the end of the program, which is a battalion stronger, compared with the time of completion of the 1981 Mid-Term Operations Estimates. But judging from the number of 74-type tanks to be produced, nearly two battalions' equivalent of 61-type tanks will remain even after completion of the new program. It seems that there is no longer the hope of realizing the desirable situation where all 74-type tanks will retire as soon as TKX's are manufactured and readied for combat use.

But the official decision to realize the TKX is welcome news anyway. Judging by 30 as the number of TKX's, their provisional adoption will take place in fiscal 1988; two will be procured that year and 14 (number for a company) will be procured in fiscal 1989 and another in fiscal 1990. So, their standard item number will be "88-type," as has been reported.

The artillery pieces comprise FH70 155-mm howitzers, 203-mm self-propelled howitzers and 64-type 81-mm mortars. The FH70 howitzers are meant as replacement to general support battalions in the mainland divisions and it seems likely that, by the time of completion of the program, all artillery pieces in the possession of these battalions will be FH70's. The 203-mm self-propelled guns are meant as replacements to the artillery brigade and artillery groups under the direct command of army headquarters and these will be mainly used by not only the 1st Artillery Brigade in Hokkaido but also the two artillery groups in the mainland (those under the Northeastern and Western Armies). The 81-mm mortars are the Japanese-made 64-type to replace U.S.-supplied mortars which are becoming superannuated.

Since the number of artillery pieces procured during the past 5 years was about 370, the number proposed by this program is smaller by about 100. This is due to the fact that the procurement of 75-type 155-mm self-propelled howitzers for the Northern Army has already been generally completed; it is unlikely to be an effect directly of the "emphasis on the navy and the air force."

The number of armored cars, another prop of the armored striking force, to be procured under the program will increase about three-fold, compared with approximately 100, the total of 73-type armored cars and 82-type command communications cars procured during the past 5 years. However, they are various, comprising the 73- and 82-types as well as new items of equipment: armored combat car and reconnaissance/security car. It is all right that the armored cars are thus becoming variegated even to form a family in some instances but there is the prospect that they will become available in only small numbers though in a wide variety. Since armored cars are insufficient as is, there could be the choice either to procure 73-type armored cars only, putting up with its somewhat inferior performance, or concentrate on armored combat cars as a luxury item. A tendency to want everything is understandable but it could lead nowhere but to the outcome that everything is insufficient. This may apply to all kinds of procurement.

The program clearly stresses antitank capabilities. The drastic decision to adopt 23 aircraft and antitank guided missiles (which may consist solely of 79-type heavy MAT's or may include medium MAT's, a new item of equipment) seems to point to the success of the recent heavy MAT test firing at sea targets. The decision is drastic in view of the fact that about 50 79-type heavy MAT's were procured piecemeal over the past 5 years. The proposed procurement of 43 AHLS's is also welcome; it may be a sign of the progress of improvement of the necessary production line. If the development of medium MAT's makes smooth progress as the result and light antitank firearms are modernized, the only problem left will be their numbers. At the same time,

the infantry will have to be reorganized and reequipped so as to shift its emphasis from machineguns and mortars to antitank weapons.

Does Division Reorganization Mean Diversification and Modernization?

The program proposes to modernize the divisions and diversify their organization in conjunction with the improvement of the ability to cope with invasion from the air to the sea and the improvement of responsiveness and the ability to continue fighting, which was discussed in the preceding chapter. This is going to be the greatest occurrence since the division reorganization of 18 January 1962 (in the meantime, there was the reform of the 7th Division into an armored outfit in March 1981) and is likely to fundamentally affect the ground combat capabilities. This chapter is provided for the discussion of this matter.

Diversification and Modernization

Since 1962, the divisions of the Ground Self Defense Force have, with the exception of the armored 7th Division, been divided into Type A with a table of organization strength of 9,000 men and Type B with a strength of 7,000 men but, in substance, they have been all but equal.

These will be further divided into six types: A, B, C, D, E and F, as in the rating system of former times, comprising five types: Northern Army Type A (2d Division of Asahikawa and 11th Division of Makomanai), Northern Army Type B (5th Division of Obihiro), 9th Division of Aomori for which the present organization will be retained because of the importance attached to Seikan (Aomori-Hakodate) Area, Type A south from the 6th Division inclusive (6th Division of Jinmachi, 1st Division of Nerima, 3d Division of Senzo, 4th Division of Fukuoka and 8th Division of Kitakumamoto) and Type B in the same region (12th Division of Somabara, 10th Division of Moriyama and 13th Division of Kaidaichi) plus the 7th Division.

So far, a Type A division has been composed, mainly, of four infantry regiments (including one motorized), an artillery regiment (self-propelled for the Northern Army only) a tank battalion (60 tanks) and an antitank unit (eight MAT's or heavy MAT's, 8 106-mm recoilless rifles and, if adopted, 16 medium MAT's). According to the program, a division of the Northern Army Type A will be composed of four infantry regiments (one armored car and three motorized cars), a tank battalion (74 tanks; this "battalion" in officially announced data will be upgraded to regiment since it equals a tank regiment of the 7th Division in the number of tanks), an antitank unit (16 heavy MAT's). A Type A division south from the 6th Division inclusive will be composed of four infantry regiments (all motorized), a tank battalion (44 tanks; a company will be transferred for duty in Hokkaido) and an antitank unit (16 heavy MAT's and 16 medium MAT's). The former Type B divisions, each with three infantry regiments, will be reorganized similar to the Type A divisions.

In short, a tank company will be turned over from each division south from the 6th Division inclusive to the Northern Army and the antitank unit in each of these divisions will be somewhat expanded.

But can this really be diversification? In the light of the geographical characteristics of Japan, diversification should, instead, be by functions, e.g., division specialized in counterlanding by sea, air maneuver division and alpine division. As for modernization, should it not be combining infantry, artillery, tank and antitank services down to the level of infantry regiment--if possible, to the company level? Reorganizing clearly is formidable work, but what the program proposes is moving units about, mere makeshift business.

The 9th Division, in spite of its status as a Type B division, will retain its present organization because of the importance of Seikan Area. If so, this division should be placed under the Northern Army as it was in the days of U.S. occupation and the days of the 2d District. Another effective way of operation could be to set up a new Tsugaru Strait Joint Command and place the 9th Division under its control. That is what a reorganization should be like.

Concentration of Tanks

As stated, a tank company will be pulled out of each division south from the 6th Division inclusive to be used in Hokkaido. The total number of tanks affected will be about 140. There is already tank concentration in Hokkaido. Data show that 530 (47 percent) are located north from Seikan Area, 450 (39 percent) are located south from the 6th Division and 160 (14 percent) are used for training. Tank concentration will be stepped up with 730 (60 percent) for north from Seikan Area, 310 (26 percent) for south from the 6th Division and 170 (14 percent) for training.

This is out-and-out concentration. It is all right to form a priority point but one cannot but worry, wondering if the Soviets will really come to Hokkaido. This worry is a natural result of the "defense only" national policy. Defense is easier said than done; it is a hard strategy. Anyway, as the background of this all-out concentration, there is the problem of exercise grounds adequate for the thorough training of tank units besides the purely military notion that the invasion of Hokkaido is highly probable. An honest confession to this effect would convince one and evoke his sympathy. As it is, they do not explain this and speak as if they were going to do something noble. This is a problem.

Balance Between the Front and the Rear

It is either a Japanese characteristic or it is due to rearmament, begun too suddenly, but there seems to have been a strong tendency to neglect the rear. "Why worry about the rear when we do not have enough for the front?" may have been the subconscious thought that was at work. But it is encouraging to be told that the combat services are not the only choices of elite Defense Academy graduates. Too much importance cannot be attached to

the rear since it is the superiority of the foundation of support for the frontline that decides the issue of a battle.

In the estimates under this program, ¥4.750 trillion (25.8 percent) will go to the front, ¥6.050 trillion (32.9 percent) to the rear and ¥7.6 trillion (41.3 percent) to personnel and rations. This budget seems to be well-balanced. With it, the program proposes to 1) improve intelligence, reconnaissance and command communication capacities, 2) improve the ability to continue fighting, the readiness to respond and defend, 3) step up education and training, 4) advance technical research and development and 5) improve quality of life for servicemen.

Improvement of Transport Capacity and Maneuverability

This is to be financed with expenses for the front and properly should be included in the chapter concerning equipment modernization. However, it is given in this chapter as a power to support the frontline. Emphasis has always been laid on the importance of air and sea maneuverability for the geographical reason that Japan is long from north to south, but this maneuverability has not been easily achieved.

Regarding transport planes, seven C130H's will be added, bringing the number of C130H's up to 14, compared with 26 for C1's. Meanwhile, YS11's will no longer be used. The main force in the GSDF helicopter transport will shift from V107's to CH47's, bringing the number of CH47's up to 25, compared with nine for V107's. The number of CH47's in ASDF possession will also increase to 14. This will give latitude to the operation of the airborne brigade, making the heliborne operation of an entire infantry regiment possible.

Transport ships and craft are another aspect that has been neglected. Landing craft may seem to be unnecessary because of the "defense only" policy but they have many uses including counterlanding and the transportation of troops to be used in the northward counterattack. It is important to use private ferryboats, etc., but transport ships and craft to be used as the nucleus are absolutely necessary. Under this program, one LST (3,500 tons) and three LCU's (420 tons) will be procured, bringing the numbers of LST's and LCU's up to, respectively, seven and five.

Strengthening of Intelligence, Reconnaissance, and Command Communication Capacities

The modernization of the automatic warning organization and the improvement of various means of intelligence collection are a keynote. However, the program merely proposes "separate study" regarding the OTH radar. So far, there has been just one ASDF reconnaissance unit of 13 RF4E's but 17 F4EJ's will be converted for reconnaissance use as they become superfluous with the progress of procurement of F15's. It is not known whether the conversion means just providing a reconnaissance pod or regularly remodeling into the RF type.

The other keynote is improvement of the command communication capacity including modernization of the defense communications network and utilization of communications satellites. The defense communications network will be digitalized. Also, optical communications, which is resistant to jamming, will be used for many purposes.

Stepup of Ability To Continue Fighting and Invulnerability

The ability to continue fighting is, it seems, the question of replenishment and ammunition. The program makes no mention of replenishment but considerably emphasizes the storage of ammunition. As for invulnerability, the improvement of air defense firearms will be expanded from the six bases north from Komatsu-Misawa, as in the past, to 17 bases north from Komatsu-Atsugi-Hyakuri. The air defense firearms comprise the short SAM, the portable SAM and the Vulcan anti-aircraft automatic cannon.

Expansion of Education and Training

As far as facets that can be indicated with figures are concerned, there will be one training ship (which will be named Kashima in any event), one training support ship to back up the increase of DDG's and 93 medium training planes (T4's). Besides, the program proposes to expand simulation equipment and increase the number of flight hours for fighter pilots. Increasing flight hours is all right but reconsidering training air space will also be necessary.

Advance of Technical Research and Development

The Technical Research and Development Institute budget for fiscal 1985 represented 1.8 percent of the defense costs and the program proposes to raise this rate to 2.5 percent by fiscal 1990, the year of its completion. It does not mention definite themes, naming them vaguely as ship-carried antisubmarine helicopter system, various guided missiles and so forth. In the area of research, there are such items as air tanker, marine air defense system and OTH radar.

Improving Quality of Life for Servicemen

The program proposes to proceed with necessary personnel and health measures including improved treatment for servicemen in order to secure the necessary number of servicemen and build their morale. If the program had named a single such measure, it could help to build the morale but there was no mention of measures. Perhaps, these measures consist, mainly, of improving barracks and welfare facilities.

The best of all measures to build morale is to let them have equipment that can knock out any enemy, let them fire unsparingly, and have a good system of family support and benefits to enable them to serve without worrying about their families.

"Poverty is a virtue" was a traditional Japanese motto, but now there is no point in forcing this idea upon others or trying to convince them by saying, "I myself experienced it."

Their pay cannot be increased arbitrarily, of course, but it should be possible to improve their government housing or think of the education of their children.

"My shack is my pride" is a thing of the past. If a serviceman's children can receive higher education when he serves away from his home, his morale will be high, even if that means a decrease in the number of tanks or if he is not promoted beyond the rank of, say, captain. It is regrettable that these considerations have been lacking for more than 30 years. This must be pointed out in conclusion.

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ENERGY

GOVERNMENT HAILS IEA STATEMENT ON OIL PRICE ISSUE

OW110957 Tokyo KYODO in English 0921 GMT 11 Apr 86

[Text] Tokyo, 11 April KYODO -- Japan on Friday welcomed reaffirmation by the International Energy Agency (IEA) of the industrial west's common recognition of falling oil prices as a major issue facing the world economy.

"The conclusions Thursday by the IEA governing board have fully taken our country's views into account," a foreign ministry official commented.

The official noted that the IEA statement was important in that it referred to "significant macroeconomic benefit in member countries" and negative impact for some member countries as a result of declining oil prices.

The IEA statement also mentioned the importance of a "better balance of underlying energy supply and demand which is most conducive to long-term stability of energy market conditions and energy supply security," a boost in oil stockpiles and continued efforts to conserve energy and develop alternative sources of energy.

The views contained in the IEA communique will be expressed in some form at a ministerial meeting of the Organization for Economic Cooperation and Development (OECD) in Paris April 17-18 and the Tokyo summit of seven major industrial countries in Tokyo May 4-6, foreign ministry officials said.

A foreign ministry source said, however, that the 22-member, Paris-based IEA rejected Japan's suggestion to mention in Thursday's conclusions the need for stable oil prices due to opposition primarily from the United States and Britain.

The U.S. emphasized market forces, the source said, while the British delegation was against the Japanese proposal for fear that such a pronouncement by the IEA would have immeasurable impact on the Organization of Petroleum Exporting Countries (OPEC) and others.

The IEA groups 22 members of the 24-member OECD, including the U.S. and Japan, but France is not a member. The Tokyo summit is to be attended by leaders of the U.S., Canada, Britain, France, Italy, West Germany, Japan and the European community.

Japanese Government officials hinted that falling oil prices and their impact on the world economy will be covered at length by both the OECD meeting and the Tokyo summit.

"In the long term, neither concerns about energy supply security, nor the need for continuity in energy policy objectives have been removed by lower oil prices," the IEA statement said. "On the contrary, a prolonged period of relatively low oil prices might intensify those concerns and bring forward the period when tighter energy markets can be expected."

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ENERGY

BRIEFS

ORGANIC ELECTRODE BATTERY--Tokyo, 19 May KYODO--A Japanese firm claimed Monday it has developed a new, highly efficient battery using an organic semiconductor as an electrode. A spokesman for Kanebo Ltd., an Osaka-based synthetic fiber maker, said the new battery will make it possible to recharge an electric razor in just ten minutes against two hours for a conventional battery. He said Kanebo will prepare the battery for a wide range of commercial applications over the next two years. He said the organic semiconductor at the heart of the battery is made of polyacene, a polymer with powerful heat and acid resistance and alterable electrical conductivity. One version of the battery uses the organic semiconductor for its positive electrode with a lithium negative electrode, while a second version uses it for both electrodes, he said. The two versions have somewhat different qualities, he said, adding that the new technology involved will be discussed at a six-day international conference on synthetic metals, opening June 1 in Kyoto. [Text] [Tokyo KYODO in English 1235 GMT 19 May 86 OW]

FUEL SAVINGS FOR CUSTOMERS--Tokyo, 22 April KYODO--Electric power and gas companies will cut their rates by 1 trillion yen in June to pass on to consumers part of the windfall profits from the recent sharp rise in the exchange value of the yen as well as a steep fall in crude oil prices, government officials said. This was formally decided Monday when the Ministry of International Trade and Industry (MITI) received a report from two advisory groups -- the electricity utility industry council and the advisory committee for energy. The report recommended that the extra profits should be passed on to consumers as much as possible through a rate cut in fiscal 1986 starting this month. As a result, general households will have their power and gas rates cut by a monthly average of about 1,000 yen from June 1, ministry sources said. The sharp appreciation of the yen, coupled with the drop in crude oil prices, has brought on a steep fall in the cost of fuel imports by power and gas firms. [Text] [Tokyo KYODO in English 0007 GMT 22 Apr 86 OW]

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LASER TECHNOLOGY

IHI TO DEVELOP LASER TECHNOLOGY WITH U.S. FIRM

OW191253 Tokyo KYODO in English 1140 GMT 19 Mar 86

[Text] Tokyo, 19 March KYODO -- Ishikawajima-Harima Heavy Industries Co (IHI) said Wednesday it has reached agreements with two subsidiaries of a U.S. chemical engineering firm, Foster Wheeler Energy Corp, to jointly develop and market application technologies for IHI's variable-wavelength laser system.

The IHI tunable laser system, developed in November 1983, is used to realize laser-induced chemical reactions instead of the conventional thermochemical reactions.

It can freely generate laser beams of various wavelengths from the infrared region (4.0 microns) to the far-out ultraviolet region (up to 0.1966 microns), whereas conventional devices produce only single wavelength laser pulses.

The tunable laser system can produce an intense laser beam of up to 300 kilowatts.

As an example of the system's application to biotechnology, IHI used the laser system last September to successfully extract useful substances from microbes.

The agreements with Foster Wheeler U.S.A. Corp and Foster Wheeler Development Corp call for IHI to conduct application tests to determine and evaluate conditions suitable for the production of marketable substances.

Based on the findings of the tests, IHI, Foster Wheeler and a client company will conclude a joint R and D agreement to improve IHI's existing laser processes or develop new laser processes suited to the clients' needs, the spokesman said.

The three-year accord also calls for both IHI and Foster Wheeler to extend engineering services to the client so as to implement the new processes, he said.

The laser system is also expected to be applied to the laser chemical vapor deposition process for the manufacture of semiconductors.

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